ISO TC184/SC4/WG 3 N 600

Date: 1997-06-06

Supersedes ISO TC184/SC4/WG 3 N 559

ISO/CD 10303-221

Product data representation and exchange: Application Protocol: Functional data and their schematic representation for process plant

ABSTRACT:

This document specifies the information model for part 221 (Functional data and their schematic representation for process plant) of ISO 10303. It addresses the objects (systems and equipment) within a process plant, their identification, classification, connectivity, composition and properties. It also addresses representation of the objects as a piping and instrumentation diagram (P&ID).

KEYWORDS:

AP, piping system, functional data, schematic representation, process plant

COMMENTS TO READER:

This document has been reviewed and noted by the ISO TC184/SC4 Quality Committee and SC4 Secretariat and has been determined to be ready for this ballot cycle.

The preparation of this document has been funded in part by EC ESPRIT project no: 6212 ProcessBase; in part by the UK PISTEP project; and in part by the Netherlands SPI-NL.

The information requirements of this part of ISO 10303 require extensions to ISO 10303-41 which are described in document ISO TC184/SC4 N539.

Project leader: Jeroen Kingma
Address: AKZO Nobel Engineering b.v.,
Velperweg 76, P.O. Box 9300,
6800 SB Arnhem,
The Netherlands
Telephone: +31 26 366 31 80
Telefacsimile: +31 26 366 34 01
Electronic mail: jeroen.kingma@arnhem.akzonobel.nl

Project editor: David Leal
Address: C.E.D.A.R. Limited,
90, London Road,
London, SE1 6LN,
UK
Telephone: +44 171 922 8823
Telefacsimile: +44 171 922 8855
Electronic mail: david@cedarlon.demon.co.uk

Contents Page

1 Scope 1

2 Normative references 5

3 Definitions and abbreviations 6
3.1 Terms defined in ISO 10303-1 6
3.2 Terms defined in ISO 10303-31 7
3.3 Terms defined in ISO 10303-42 7
3.4 Terms defined in ISO 10303-46 7
3.5 Other definitions 7
3.5.1 actual 8
3.5.2 assembly 8
3.5.3 catalogue 8
3.5.4 class 9
3.5.5 collection 9
3.5.6 component 10
3.5.7 connection 10
3.5.8 construction material 10
3.5.9 data context object 10
3.5.10 equipment 10
3.5.11 functional 11
3.5.12 information holder 11
3.5.13 instrument 11
3.5.14 insulation 11
3.5.15 intended 11
3.5.16 material stream 12
3.5.17 physical 12
3.5.18 pipe 12
3.5.19 piping and instrumentation diagram (P&ID) 13
3.5.20 process plant 13
3.5.21 plant item 13
3.5.22 plant system 13
3.5.23 presentation 13
3.5.24 process activity 13
3.5.25 process flow diagram (PFD) 14
3.5.26 process material 14
3.5.27 relevant data 14
3.5.28 schematic presentation 14
3.5.29 site 14
3.5.30 specific 14
3.5.31 typical 15
3.6 Abbreviations 15

4 Information requirements . . . 16
4.1 Units of functionality . . . 16
4.1.1 activity UoF . . . 20
4.1.2 administration UoF . . . 23
4.1.3 approval UoF . . . 24
4.1.4 catalogue_of_standard_items UoF . . . 25
4.1.5 classification_of_plant_item UoF . . . 26
4.1.6 composition_and_connection_of_plant_item UoF . . . 27
4.1.7 data_inheritance UoF . . . 28
4.1.8 effect UoF . . . 29
4.1.9 hierarchical_decomposition UoF . . . 30
4.1.10 identification UoF . . . 30
4.1.11 information_and_document UoF . . . 32
4.1.12 involvement_constraint UoF . . . 34
4.1.13 library_of_classes UoF . . . 35
4.1.14 life_cycle UoF . . . 37
4.1.15 plant_item UoF . . . 37
4.1.16 position_and_orientation UoF . . . 38
4.1.17 process_material_and_substance UoF . . . 39
4.1.18 property UoF . . . 40
4.1.19 required_information UoF . . . 41
4.1.20 schematic_appearance UoF . . . 42
4.1.21 schematic_presentation_and_layout UoF . . . 43
4.1.22 variance_and_derivation UoF . . . 45
4.2 Application objects . . . 46
4.3 Application assertions . . . 203

5 Application interpreted model . . . 480
5.1 Mapping table . . . 480
5.2 AIM EXPRESS short listing . . . 738

6 Conformance requirements . . . 869

Annexes

A AIM EXPRESS expanded listing . . . 892
B AIM short names . . . 1003
C Implementation method specific requirements . . . 1022
D Protocol Implementation Conformance Statement (PICS) proforma . . . 1024
E Information object registration . . . 1025
E.1 Document identification . . . 1025
E.2 Schema identification . . . 1025
F Application activity model . . . 1026
F.1 Application activity model definitions and abbreviations . . . 1026
F.1.1 Analyze Final Plant Design (AAM A245) . . . 1026
F.1.2 As-built Documents*† . . . 1026
F.1.3 Authorization Plan* . . . 1026

F.1.4 Automation Tools* . . . 1026
F.1.5 Basic Laws* . . . 1027
F.1.6 Bids* . . . 1027
F.1.7 Calculate Heat/Mass Balance (A212): . . . 1027
F.1.8 Capital Appropriation*: . . . 1027
F.1.9 Change Request: . . . 1027
F.1.10 Chemical Properties*† . . . 1027
F.1.11 Codes*† . . . 1028
F.1.12 Commission Plant (AAM A46) . . . 1028
F.1.13 Commissioned Plant . . . 1028
F.1.14 Commissioning Procedures*† . . . 1028
F.1.15 Company Requirements* . . . 1029
F.1.16 Confirm Safety and Regulatory Compliance (AAM A244) . . . 1029
F.1.17 Construct and Commission Plant (AAM A4) . . . 1029
F.1.18 Construction Design Specification*† . . . 1029
F.1.19 Construction Documentation*† . . . 1029
F.1.20 Construction Plan* . . . 1029
F.1.21 Construction Services* . . . 1029
F.1.22 Control and Approve Activities (AAM A11) . . . 1030
F.1.23 Control Requirements* . . . 1030
F.1.24 Corporate Standards*† . . . 1030
F.1.25 Decommission and Dispose of Plant (AAM A6) . . . 1030
F.1.26 Decommission Plant (AAM A61) . . . 1030
F.1.27 Define Plant Operating Philosophy (AAM A231) . . . 1030
F.1.28 Define Procedures, Standards, Guidelines, Specifications, and Codes (AAM A13) 1031
F.1.29 Delivery Dates* . . . 1031
F.1.30 Deploy Component/Service (AAM A35) . . . 1031
F.1.31 Design Basis*† . . . 1031
F.1.32 Design Plant (AAM A2) . . . 1032
F.1.33 Design Strategy* . . . 1032
F.1.34 Disassembled Plant . . . 1032
F.1.35 Discipline Experts* . . . 1032
F.1.36 Disposal Documentation*† . . . 1032
F.1.37 Dispose of Plant (AAM A62) . . . 1033
F.1.38 Energy* . . . 1033
F.1.39 Engineer/Design Equipment (AAM A223) . . . 1033
F.1.40 Engineer/Design Plant Systems (AAM A222) . . . 1033
F.1.41 Engineering Design, Construction, and Operation Changes . . . 1033
F.1.42 Environmental Impact Assessment*† . . . 1033
F.1.43 Equipment Characteristics . . . 1033
F.1.44 Equipment ID . . . 1034
F.1.45 Equipment List . . . 1034
F.1.46 Erect Plant (AAM A43) . . . 1034
F.1.47 Establish Initial Process Control Logic (AAM A214) . . . 1034
F.1.48 Establish Plant Design Basis (AAM A16) . . . 1034
F.1.49 Evaluate Bids and Negotiate Purchase (AAM A33) . . . 1035

F.1.50 Finalize Layout/Arrangement/Spatial Design (AAM A242) . . . 1035
F.1.51 Finalize System Design (AAM A241) . . . 1035
F.1.52 Guidelines/Requirements* . . . 1035
F.1.53 Heat/Mass Calculations*† . . . 1035
F.1.54 Identify Plant Performance Requirements and Establish Design Strategy (AAM A221) . . . 1036
F.1.55 Identify/Analyze Safety Requirements/Hazards (AAM A215) . . . 1036
F.1.56 Identify/Define Unit Operations (AAM 211) . . . 1036
F.1.57 Identify/Size Equipment (AAM A213) . . . 1036
F.1.58 Information Databases*† . . . 1036
F.1.59 Initial Information*† . . . 1036
F.1.60 Innovation* . . . 1036
F.1.61 Inspection plan* . . . 1037
F.1.62 Inspection Requirements*† . . . 1037
F.1.63 Inspection Results*† . . . 1037
F.1.64 Layout Plant (AAM A224) . . . 1037
F.1.65 Licensed Technologies . . . 1037
F.1.66 Line Schedule/List . . . 1037
F.1.67 Maintain Plant (AAM A53) . . . 1037
F.1.68 Maintain Suppliers List (AAM A31) . . . 1038
F.1.69 Manage and Plan Project (AAM A1) . . . 1038
F.1.70 Manage Plant (AAM A51) . . . 1038
F.1.71 Manage, Operate, and Maintain Plant (AAM A5) . . . 1038
F.1.72 Management Authorizations/Controls*† . . . 1038
F.1.73 Obtain Agreements with Regulatory Bodies (AAM A15) . . . 1038
F.1.74 Obtain Construction Services (AAM A42) . . . 1038
F.1.75 Operate Plant (AAM A52) . . . 1038
F.1.76 Operating Philosophy* . . . 1039
F.1.77 Operating Procedures*† . . . 1039
F.1.78 Optimize for Environment (AAM A236) . . . 1039
F.1.79 Owner Requirements*† . . . 1039
F.1.80 Perform Process Plant Life Cycle Activities (AAM A0) . . . 1039
F.1.81 Personnel . . . 1039
F.1.82 Piping and Instrumentation (P&I) Diagram . . . 1039
F.1.83 Plan/Analyze Project Finances (AAM A14) . . . 1040
F.1.84 Plant . . . 1040
F.1.85 Plant Design Documentation*† . . . 1040
F.1.86 Plant Items . . . 1040
F.1.87 Plant Life Cycle Documentation*† . . . 1040
F.1.88 Plant Operation/Maintenance Documentation*† . . . 1040
F.1.89 Plant Performance Requirements . . . 1041
F.1.90 Plant Records*† . . . 1041
F.1.91 Pre-commission Plant (AAM A45) . . . 1041
F.1.92 Pre-commissioned Plant . . . 1041
F.1.93 Prepare Bid Packages and Solicit Bids (AAM A32) . . . 1041
F.1.94 Process Control Logic . . . 1041

F.1.95 Process Flow Diagram (PFD) . . . 1041
F.1.96 Procure Components (AAM A3) . . . 1042
F.1.97 Procured item . . . 1042
F.1.98 Produce As-built Surveys (AAM A44) . . . 1042
F.1.99 Produce Conceptual Plant Design (AAM A22) . . . 1042
F.1.100 Produce Conceptual Process Design (AAM A21) . . . 1042
F.1.101 Produce Conceptual Safety Engineering Designs (AAM A225) . . . 1042
F.1.102 Produce Construction Plans (AAM A41) . . . 1043
F.1.103 Produce Final Plant Design (AAM A24) . . . 1043
F.1.104 Produce Final Process Design (AAM A23) . . . 1043
F.1.105 Produce Process Flow Diagrams (AAM A216) . . . 1043
F.1.106 Project Authorizations/Controls*† . . . 1043
F.1.107 Project Control and Approval Documentation* . . . 1043
F.1.108 Project Financial Plan* . . . 1043
F.1.109 Project Specific Procedures/Standards/Guidelines/Specifications/Codes*† . . . 1044
F.1.110 Provide Resources (AAM A12) . . . 1044
F.1.111 Purchase Agreement* . . . 1044
F.1.112 Qualified Construction Firms* . . . 1044
F.1.113 Receive, Inspect, and Disposition Components (AAM A34) . . . 1044
F.1.114 Regulatory Agreements* . . . 1044
F.1.115 Regulatory Authorizations* . . . 1044
F.1.116 Regulatory requirements*† . . . 1044
F.1.117 Request for Management Approval . . . 1045
F.1.118 Residual Materials*† . . . 1045
F.1.119 Resources*† . . . 1045
F.1.120 Safety Compliance Reports* . . . 1045
F.1.121 Safety HazOps Analysis* . . . 1045
F.1.122 Safety System Specification*† . . . 1045
F.1.123 Satisfy Safety Requirements (HazOps) (AAM A235) . . . 1045
F.1.124 Schedules* . . . 1045
F.1.125 Schematic Diagrams . . . 1046
F.1.126 Site Information*† . . . 1046
F.1.127 Societal Requirements* . . . 1047
F.1.128 Specifications and Standards*† . . . 1047
F.1.129 Specify Building and Plant Services (AAM A243) . . . 1047
F.1.130 Specify Control Requirements (AAM A234) . . . 1047
F.1.131 Specify Equipment Functional Characteristics (AAM A233) . . . 1047
F.1.132 Specify Piping and Instrumentation (AAM A232) . . . 1048
F.1.133 Starting Materials*† . . . 1048
F.1.134 Status*† . . . 1048
F.1.135 Stream Data . . . 1048
F.1.136 Suppliers List* . . . 1048
F.1.137 System Layout/Design . . . 1048
F.1.138 Time/Cost Estimates* . . . 1049
F.1.139 Unit Operations . . . 1049
F.1.140 Useful Products . . . 1050

F.1.141 Vendor Documentation*† . . . 1050
F.2 Application activity model diagrams . . . 1050
G Application reference model . . . 1064
H AIM EXPRESS-G . . . 1090
J AIM EXPRESS listing . . . 1150
K Application protocol usage guide . . . 1151
K.1 Introduction . . . 1151
K.2 A usage scenario . . . 1151
K.2.1 The scene . . . 1151
K.2.2 The role played by AP 221 . . . 1152
K.2.3 Relationship to the Application Activity Model . . . 1155
L Technical discussions . . . 1157
L.1 Introduction . . . 1157
L.1.1 Purpose of the example . . . 1157
L.1.2 Engineering scope of the example . . . 1157
L.1.3 Nomenclature of the example . . . 1157
L.2 Process plant definition . . . 1159
L.2.1 Processes . . . 1159
L.2.2 Facility assembly levels . . . 1161
L.2.3 Schematic representation . . . 1166
L.2.4 Properties . . . 1167
L.3 Identification of piping . . . 1171
L.3.1 Business rules . . . 1171
L.3.2 Labelling of items . . . 1171
L.3.3 Documents . . . 1172
L.4 The life of a process plant . . . 1173
L.4.1 The life of an item in a process plant . . . 1173
L.4.2 Describe an item . . . 1175
L.4.3 Beginning and end of life of an item . . . 1177
L.4.4 Start and terminate associations . . . 1178
L.5 Tables of instances . . . 1179
L.5.1 Demonstration plant ‘unit 4500’ - process Activity . . . 1179
L.5.2 Demonstration plant ‘unit 4500’ - Facility and Material . . . 1182
L.5.3 Demonstration plant ‘unit 4500’ - Property . . . 1206
L.5.4 Demonstration plant ‘unit 4500’ - Information_content . . . 1206
M Specified instances of application objects . . . 1210
M.1 Specified instances of Class_of_activity . . . 1213
M.1.1 Specified instances of Class_of_activity for Design . . . 1213
M.1.2 Specified instances of Class_of_activity for processes . . . 1213
M.2 Specified instances of Class_of_annotation_element . . . 1215
M.3 Specified instances of Class_of_facility . . . 1217
M.3.1 Specified instances of Class_of_facility for a Connector_of_facility . . . 1218
M.3.2 Specified generic instances of Class_of_facility . . . 1220
M.3.3 Specified instances of Class_of_facility for heat transfer . . . 1221
M.3.4 Specified instances of Class_of_facility for instrumentation and control . . . 1224
M.3.5 Specified instances of Class_of_facility for piping and insulation . . . 1237

M.3.6 Specified instances of Class_of_facility for plants and systems . . . 1241
M.3.7 Specified instances of Class_of_facility for rotating and reciprocating equipment 1249
M.3.8 Specified instances of Class_of_facility for valves . . . 1256
M.3.9 Specified instances of Class_of_facility for vessels . . . 1260
M.3.10 Specified instances of Class_of_facility for Logical_information_carrier . . . 1265
M.4 Specified instances of Class_of_information_content . . . 1266
M.4.1 Specified instances of Class_of_information_content for design documentation . 1266
M.4.2 Specified instances of Class_of_information_content for identification . . . 1268
M.4.3 Specified instances of Class_of_information_content for natural language . . . 1269
M.5 Specified instances of Class_of_involvement . . . 1270
M.6 Specified instances of Class_of_material . . . 1272
M.6.1 Specified instances of Class_of_material for generic classification . . . 1272
M.6.2 Specified instances of Class_of_material for heat transfer . . . 1274
M.6.3 Specified instances of Class_of_material for heat transfer equipment components 1278
M.6.4 Specified instances of Class_of_material for instrumentation and control . . . 1282
M.6.5 Specified instances of Class_of_material for instrumentation and control components . . . 1286
M.6.6 Specified instances of Class_of_material for piping and insulation . . . 1288
M.6.7 Specified instance of Class_of_material for plants and systems . . . 1295
M.6.8 Specified instances of Class_of_material for rotating and reciprocating equipment 1296
M.6.9 Specified instances of Class_of_material for rotating equipment components . . . 1305
M.6.10 Specified instances of Class_of_material for Valves . . . 1322
M.6.11 Specified instances of Class_of_material for Valve components . . . 1328
M.6.12 Specified instances of Class_of_material for vessels . . . 1330
M.6.13 Specified instances of Class_of_material for Vessel components . . . 1333
M.6.14 Specified instances of Class_of_material for Physical_information_carrier . . . 1341
M.7 Specified instances of Class_of_property . . . 1342
M.7.1 Specified instances of Class_of_property for Material and Activity . . . 1345
M.7.2 Specified instances of Class_of_property for any composition . . . 1355
M.7.3 Specified instances of Class_of_property for a Physical_information_carrier . . . 1355
M.8 Specified instances of Class_of_substance . . . 1356
M.8.1 Specified instances of Class_of_substance for phase . . . 1356
M.8.2 Specified instances of Class_of_substance for process material . . . 1357
M.9 Specified enumerated Properties . . . 1373
M.9.1 Specified enumerated instances of Property that are Colours . . . 1373
M.10 Specified instances of Recognized_involvement_for_activity_according_to_class . . . 1374
M.10.1 Specified instances of Recognized_involvement_for_activity_according_to_class for Design . . . 1374
M.10.2 Specified instances of Recognized_involvement_for_activity_according_to_class for processes . . . 1375
M.11 Specified instances of Classification_of_class_of_facility . . . 1376
M.12 Specified instances of Classification_of_class_of_material . . . 1395
N Specified instance listing . . . 1431
P Bibliography . . . 1432

Index . . . 1433

Figures

1 Functional and physical aspects of a plant item . . . lxviii
2 Example of a P&ID for a petro-chemical plant system . . . lxix
3 Data planning model showing principal objects and their classification . . . lxxi
4 Data planning model showing description, presentation and configuration management . . . lxxii
5 Outline of the references between UoFs . . . 19
6 An Annotation_area with an inner and outer boundary . . . 53
7 An Annotation_curve with a specified Line_pattern and Line_width . . . 54
8 An Annotation_text . . . 57
9 An Annotation_element that is an assembly. . . . 61
10 The connection of three piping branches at a node . . . 91
11 A Connector_feature_of_annotation_element . . . 94
12 An Annotation_element placed on a Physical_information_carrier . . . 102
13 A Direction_range_for_connector_feature . . . 109
14 An Annotation_area hatching pattern . . . 116
15 An Annotation_curve with Terminator_symbol . . . 130
16 A Page_connector . . . 143
17 Connectors of assemblies and parts of assemblies . . . 147
18 Assembly of a ball_valve_symbol . . . 158
19 Annotation_elements that have relative placement . . . 178
20 An Annotation_area with tiling pattern . . . 188
21 Topologic sequence within a Piping_segment . . . 190
22 Material object used in a bolted connection . . . 195
F.1 IDEF0 basic notation . . . 1051
F.2 A-0 - process plants . . . 1052
F.3 A0 - perform process plant life cycle activities . . . 1053
F.4 A1 - manage and plan project . . . 1054
F.5 A2 - design plant . . . 1055
F.6 A21 - produce conceptual process design . . . 1056
F.7 A22 - produce conceptual plant design . . . 1057
F.8 A23 - produce final process design . . . 1058

F.9 A24 - produce final plant design 1059
F.10 A3 - procure components 1060
F.11 A4 - construct and commission plant 1061
F.12 A5 - manage, operate and maintain plant 1062
F.13 A6 - decommission and dispose of plant 1063
G.1 ARM diagram 1 of 23 in Express-G 1065
G.2 ARM diagram 2 of 23 in Express-G 1066
G.3 ARM diagram 3 of 23 in Express-G 1068
G.4 ARM diagram 4 of 23 in Express-G 1069
G.5 ARM diagram 5 of 23 in Express-G 1071
G.6 ARM diagram 6 of 23 in Express-G 1072
G.7 ARM diagram 7 of 23 in Express-G 1073
G.8 ARM diagram 8 of 23 in Express-G 1074
G.9 ARM diagram 9 of 23 in Express-G 1075
G.10 ARM diagram 10 of 23 in Express-G 1076
G.11 ARM diagram 11 of 23 in Express-G 1077
G.12 ARM diagram 12 of 23 in Express-G 1078
G.13 ARM diagram 13 of 23 in Express-G 1079
G.14 ARM diagram 14 of 23 in Express-G 1080
G.15 ARM diagram 15 of 23 in Express-G 1081
G.16 ARM diagram 16 of 23 in Express-G 1082
G.17 ARM diagram 17 of 23 in Express-G 1083
G.18 ARM diagram 18 of 23 in Express-G 1084
G.19 ARM diagram 19 of 23 in Express-G 1085
G.20 ARM diagram 20 of 23 in Express-G 1086
G.21 ARM diagram 21 of 23 in Express-G 1087
G.22 ARM diagram 22 of 23 in Express-G 1088
G.23 ARM diagram 23 of 23 in Express-G 1089
H.1 AIM diagram 1 of 59 in Express-G 1091
H.2 AIM diagram 2 of 59 in Express-G 1092
H.3 AIM diagram 3 of 59 in Express-G 1093

H.4 AIM diagram 4 of 59 in Express-G 1094
H.5 AIM diagram 5 of 59 in Express-G 1095
H.6 AIM diagram 6 of 59 in Express-G 1096
H.7 AIM diagram 7 of 59 in Express-G 1097
H.8 AIM diagram 8 of 59 in Express-G 1098
H.9 AIM diagram 9 of 59 in Express-G 1099
H.10 AIM diagram 10 of 59 in Express-G 1100
H.11 AIM diagram 11 of 59 in Express-G 1101
H.12 AIM diagram 12 of 59 in Express-G 1102
H.13 AIM diagram 13 of 59 in Express-G 1103
H.14 AIM diagram 14 of 59 in Express-G 1104
H.15 AIM diagram 15 of 59 in Express-G 1105
H.16 AIM diagram 16 of 59 in Express-G 1106
H.17 AIM diagram 17 of 59 in Express-G 1107
H.18 AIM diagram 18 of 59 in Express-G 1108
H.19 AIM diagram 19 of 59 in Express-G 1109
H.20 AIM diagram 20 of 59 in Express-G 1110
H.21 AIM diagram 21 of 59 in Express-G 1111
H.22 AIM diagram 22 of 59 in Express-G 1112
H.23 AIM diagram 23 of 59 in Express-G 1113
H.24 AIM diagram 24 of 59 in Express-G 1114
H.25 AIM diagram 25 of 59 in Express-G 1115
H.26 AIM diagram 26 of 59 in Express-G 1116
H.27 AIM diagram 27 of 59 in Express-G 1117
H.28 AIM diagram 28 of 59 in Express-G 1118
H.29 AIM diagram 29 of 59 in Express-G 1119
H.30 AIM diagram 30 of 59 in Express-G 1120
H.31 AIM diagram 31 of 59 in Express-G 1121
H.32 AIM diagram 32 of 59 in Express-G 1122
H.33 AIM diagram 33 of 59 in Express-G 1123
H.34 AIM diagram 34 of 59 in Express-G 1124

H.35 AIM diagram 35 of 59 in Express-G 1125
H.36 AIM diagram 36 of 59 in Express-G 1126
H.37 AIM diagram 37 of 59 in Express-G 1127
H.38 AIM diagram 38 of 59 in Express-G 1128
H.39 AIM diagram 39 of 59 in Express-G 1129
H.40 AIM diagram 40 of 59 in Express-G 1130
H.41 AIM diagram 41 of 59 in Express-G 1131
H.42 AIM diagram 42 of 59 in Express-G 1132
H.43 AIM diagram 43 of 59 in Express-G 1133
H.44 AIM diagram 44 of 59 in Express-G 1134
H.45 AIM diagram 45 of 59 in Express-G 1135
H.46 AIM diagram 46 of 59 in Express-G 1136
H.47 AIM diagram 47 of 59 in Express-G 1137
H.48 AIM diagram 48 of 59 in Express-G 1138
H.49 AIM diagram 49 of 59 in Express-G 1139
H.50 AIM diagram 50 of 59 in Express-G 1140
H.51 AIM diagram 51 of 59 in Express-G 1141
H.52 AIM diagram 52 of 59 in Express-G 1142
H.53 AIM diagram 53 of 59 in Express-G 1143
H.54 AIM diagram 54 of 59 in Express-G 1144
H.55 AIM diagram 55 of 59 in Express-G 1145
H.56 AIM diagram 56 of 59 in Express-G 1146
H.57 AIM diagram 57 of 59 in Express-G 1147
H.58 AIM diagram 58 of 59 in Express-G 1148
H.59 AIM diagram 59 of 59 in Express-G 1149
K.1 The ProcessBase AP 221 demonstration scenario 1153
L.1 Process assembly level 1160
L.2 Unit operation 1161
L.3 Plant item assembly levels 1162
L.4 A piping network 1163
L.5 A piping segment network 1164

L.6 Information about connection material on a schematic drawing . . . 1165
L.7 Piping parts and connection material . . . 1166
L.8 Example P&ID with network level information . . . 1168
L.9 Example P&ID with segment level information . . . 1169
L.10 Example P&ID with component identification . . . 1170
L.11 Example P&ID with pipeline identification . . . 1172
L.12 Life of an intended item . . . 1176
L.13 Life of an actual item . . . 1178

Tables

1 Listing of standard instance tables . . . 21
2 Required instances of Involvement_of_object_in_activity . . . 128
3 Standard Numeric_operators . . . 137
4 Meaning of Valid_context_for_hierarchy_of_facility . . . 197
5 Meaning of Valid_context_for_hierarchy_of_material . . . 198
6 Meaning of Valid_context_for_identification . . . 199
7 Mapping table activity UoF (uof01) . . . 482
8 Mapping table administration UoF (uof02) . . . 507
9 Mapping table approval UoF (uof03) . . . 511
10 Mapping table catalogue UoF (uof04) . . . 517
11 Mapping table classification of plant item UoF (uof05) . . . 518
12 Mapping table composition and connection of plant item UoF (uof06) . . . 522
13 Mapping table data_inheritance UoF (uof07) . . . 530
14 Mapping table effect UoF (uof08) . . . 534
15 Mapping table hierarchical_decomposition UoF (uof09) . . . 539
16 Mapping table identification UoF (uof10) . . . 545
17 Mapping table information_and_document UoF (uof11) . . . 555
18 Mapping table involvement_constraint UoF (uof12) . . . 571
19 Mapping table library_of_classes UoF (uof13) . . . 575
20 Mapping table life_cycle UoF (uof14) . . . 589
21 Mapping table plant_item UoF (uof15) . . . 613
22 Mapping table position_and_orientation UoF (uof16) . . . 615

23 Mapping table process_material_and_substance UoF (uof17) . . . 619
24 Mapping table property UoF (uof18) . . . 622
25 Mapping table required_information UoF (uof19) . . . 632
26 Mapping table schematic_appearance UoF (uof20) . . . 638
27 Mapping table schematic_presentation_and_layout UoF (uof21) . . . 647
28 Mapping table variance_and_derivation UoF (uof22) . . . 678
29 Standard data for plant_functional_numeric_operator qualifiers . . . 826
30 Units of functionality and categories of information . . . 871
31 Conformance classes and categories of information . . . 872
32 Conformance class elements . . . 874
33 Conformance class standard instances . . . 890
B.1 Short names of entities . . . 1003
L.1 Natural language association names . . . 1158
L.2 A ‘from-to’ report . . . 1173
L.3 Design activities that create associations . . . 1174
L.4 Design activities that terminate associations . . . 1175
L.5 Identification and description of items . . . 1175
L.6 Beginning and end of items . . . 1177
L.7 Composition of Activity . . . 1179
L.8 Classification of Activity . . . 1180
L.9 Involvement of Process_material in Activity . . . 1181
L.10 Classification of Process_material . . . 1181
L.11 Involvement of Facility in Activity . . . 1181
L.12 Composition of Facility - network level . . . 1182
L.13 Connection of Facility - network level . . . 1183
L.14 Composition of Facility - segment level . . . 1184
L.15 Connection of Facility - segment level . . . 1185
L.16 Composition of Facility - component level . . . 1186
L.17 Composition of Facility - component level (continued) . . . 1187
L.18 Composition of Facility - component level (continued) . . . 1188
L.19 Composition of Facility - component level (continued) . . . 1189

L.20 Composition of Facility - component level (concluded) . . . 1190
L.21 Connection of Facility - component level . . . 1191
L.22 Composition of Material - part level . . . 1193
L.23 Connection of Material - part level . . . 1194
L.24 Possession of Feature . . . 1194
L.25 Connection of Feature . . . 1195
L.26 Classification of Facility - network level . . . 1196
L.27 Classification of Facility - segment level . . . 1197
L.28 Classification of Facility - component level . . . 1198
L.29 Classification of Material - part level . . . 1202
L.30 Classification of Material - part level (concluded) . . . 1203
L.31 Classification of Feature . . . 1203
L.32 Provision of service by Material . . . 1204
L.33 Property of Facility . . . 1206
L.34 Description of Facility . . . 1207
L.35 Material of construction . . . 1207
L.36 A Property and its description by Information_content . . . 1208
L.37 Information_content that is a description of a Facility . . . 1209
M.1 Specified instances of Class_of_activity for Design . . . 1213
M.2 Specified instances of Class_of_activity for processes . . . 1214
M.3 Specified instances of Class_of_annotation_element . . . 1215
M.4 Specified instances of Class_of_facility for Connector_of_facility . . . 1218
M.5 Specified instances of Class_of_facility for generic classification . . . 1220
M.6 Specified instances of Class_of_facility for heat transfer . . . 1221
M.7 Specified instances of Class_of_facility for instrumentation and control . . . 1224
M.8 Specified instances of Class_of_facility for piping and insulation . . . 1237
M.9 Specified instances of Class_of_facility for plants and systems . . . 1241
M.10 Specified instances of Class_of_facility for rotating and reciprocating equipment . . . 1249
M.11 Specified instances of Class_of_facility for valves . . . 1256
M.12 Specified instances of Class_of_facility for Vessels . . . 1260
M.13 Specified instances of Class_of_facility for Logical_information_carrier . . . 1265

M.14 Specified instances of Class_of_information_content for design documentation 1266
M.15 Specified instances of Class_of_information_content for identification 1268
M.16 Specified instances of Class_of_information_content for natural language 1269
M.17 Specified instances of Class_of_involvement 1270
M.18 Specified instances of Class_of_material for generic classification 1272
M.19 Specified instances of Class_of_material for heat transfer 1274
M.20 Specified instances of Class_of_material for heat transfer equipment components 1278
M.21 Specified instances of Class_of_material for instrumentation and control 1282
M.22 Specified instances of Class_of_material for instrumentation and control components 1286
M.23 Specified instances of Class_of_material for piping and insulation 1288
M.24 Specified instances of Class_of_material for plants and systems 1295
M.25 Specified instances of Class_of_material for rotating and reciprocating equipment 1296
M.26 Specified instances of Class_of_material for rotating equipment components 1305
M.27 Specified instances of Class_of_material for Valves 1322
M.28 Specified instances of Class_of_material for Valve components 1328
M.29 Specified instances of Class_of_material for vessels 1330
M.30 Specified instances of Class_of_material for Vessel components 1333
M.31 Specified instances of Class_of_material for Physical_information_carrier 1341
M.32 Specified instances of Class_of_property 1345
M.33 Specified instances of Class_of_property for any composition 1355
M.34 Specified instances of Class_of_property for a Physical_information_carrier 1355
M.35 Specified instances of Class_of_substance for phase 1356
M.36 Specified instances of Class_of_substance for process material 1357
M.37 Specified enumerated instances of Property that are Colours 1373
M.38 Specified instances of Recognized_involvement_for_activity_according_to_class for design . . 1374
M.39 Specified instances of Recognized_involvement_for_activity_according_to_class for processes 1375
M.40 Specified instances of Classification_of_class_of_facility 1376
M.41 Specified instances of Classification_of_class_of_material 1395

Foreword

The International Organization for Standardization (ISO) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote.

International Standard ISO 10303–221 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data*.

The preparation of this part of ISO 10303 has benefited from the technical contributions of many projects and their sponsoring organizations.

The contributions of the following are acknowledged:

- ESPRIT III, 6212, ProcessBase;
- ESPRIT IV, 20506, PIPPIN;
- PISTEP;
- SPI-NL;
- POSC/CAESAR;
- EPISTLE;
- PlantSTEP;
- pdXi.

The attention of the reader is drawn to the following:

- The Information Requirements stated in clause 4 of this part of ISO 10303 cannot be supported in full by the current version of the Integrated Resource part 41, which is referenced in clause 2.

  The AP 221 development team has proposed extensions and changes to Integrated Resource part 41 that would enable all the Information Requirements to be met. The extensions and modifications are described in document ISO TC184/SC4 N539 “Integrated generic resource: Fundamentals of product description and support (Revision of ISO 10303-41:1994)”. Document ISO TC184/SC4 N539 will be distributed along with the Committee Draft (CD) of this part of ISO 10303 in the ballot package.

Document ISO TC184/SC4 N539 also contains extensions and changes to Integrated Resource part 41 which are required by other AP projects and which are required to resolve SEDS issues. The AP 221 development team will contribute to the development of an ISO New Work Item that incorporates the proposed extensions and changes in an amendment to Integrated Resource part 41. The amended version of Integrated Resource part 41 will be a normative reference in the Draft International Standard (DIS) version of this part of ISO 10303.

– This part of ISO 10303 contains specified instances of application objects, which are defined in annex M. The standard instances are normative and are an integral part of the Information Requirements.

  As an illustration, the specified instances of the application object Class_of_material define a taxonomy for components and equipment items within a process plant. The specified instances are used to exchange information about the nature of a component or equipment item.

  An informative listing of the specified instances in electronic form is provided by annex N.

– Many of the Application Objects defined in clause 4.2 of this part of ISO 10303 have a generic definition which does not restrict their use to the exchange of information about a process plant.

  However the precise nature of each generic application object is indicated by the standard instances in annex M which provide a taxonomy. The scope of each taxonomy defines the scope of this part of ISO 10303 and in each case the scope is restricted to application objects of relevance to process plant.

– The Usage Scenario in annex K and the Technical discussion in annex L, explain how generic application objects can be combined with a taxonomy in order to exchange precise information about a process plant.

  The reader is encouraged to read annexes K and L which explain the basis of the technical approach of this part of ISO 10303.

ISO 10303 consists of the following parts under the general title *Industrial automation systems and integration – Product data representation and exchange:*

– Part 1, Overview and fundamental principles;

– Part 11, Description methods: The EXPRESS language reference manual;

– Part 12, Description method: The EXPRESS-I language reference manual;

– Part 21, Implementation methods: Clear text encoding of the exchange structure;

– Part 22, Implementation method: Standard data access interface specification;

– Part 23, Implementation method: C++ language binding to the standard data access interface;

– Part 24, Implementation method: C language binding to the standard data access interface;

- Part 26, Implementation method: Interface definition language binding to the standard data access interface;
- Part 31, Conformance testing methodology and framework: General concepts;
- Part 32, Conformance testing methodology and framework: Requirements on testing laboratories and clients;
- Part 33, Conformance testing methodology and framework: Structure and use of abstract test suites;
- Part 34, Conformance testing methodology and framework: Abstract test methods;
- Part 35, Conformance testing methodology and framework: Abstract test methods for SDAI implementations;
- Part 41, Integrated generic resources: Fundamentals of product description and support;
- Part 42, Integrated generic resources: Geometric and topological representation;
- Part 43, Integrated generic resources: Representation structures;
- Part 44, Integrated generic resources: Product structure configuration;
- Part 45, Integrated generic resource: Materials;
- Part 46, Integrated generic resources: Visual presentation;
- Part 47, Integrated generic resource: Shape variation tolerances;
- Part 49, Integrated generic resource: Process structure and properties;
- Part 101, Integrated application resource: Draughting;
- Part 104, Integrated application resource: Finite element analysis;
- Part 105, Integrated application resource: Kinematics;
- Part 106, Integrated application resource: Building construction core model;
- Part 201, Application protocol: Explicit draughting;
- Part 202, Application protocol: Associative draughting;
- Part 203, Application protocol: Configuration controlled design;
- Part 204, Application protocol: Mechanical design using boundary representation;

- Part 205, Application protocol: Mechanical design using surface representation;
- Part 207, Application protocol: Sheet metal die planning and design;
- Part 208, Application protocol: Life cycle management - Change process;
- Part 209, Application protocol: Composite and metallic structural analysis and related design;
- Part 210, Application protocol: Electronic assembly, interconnect, and packaging design;
- Part 212, Application protocol: Electrotechnical design and installation
- Part 213, Application protocol: Numerical control process plans for machined parts;
- Part 214, Application protocol: Core data for automotive mechanical design;
- Part 215, Application protocol: Ship arrangement;
- Part 216, Application protocol: Ship moulded forms;
- Part 217, Application protocol: Ship piping;
- Part 218, Application protocol: Ship structures;
- Part 220, Application protocol: Process planning, manufacture, and assembly of layered electronic products;
- Part 221, Application protocol: Functional data and their schematic representation for process plant;
- Part 222, Application protocol: Exchange of product data for composite structures;
- Part 223, Application protocol: Exchange of design and manufacturing product information for casting parts;
- Part 224, Application protocol: Mechanical product definition for process plans using machining features;
- Part 225, Application protocol: Building elements using explicit shape representation;
- Part 226, Application protocol: Ship mechanical systems;
- Part 227, Application protocol: Plant spatial configuration;
- Part 228, Application protocol: Building services: Heating, ventilation, and air conditioning;
- Part 229, Application protocol: Exchange of design and manufacturing product information for forged parts;

- Part 230, Application protocol: Building structural frame: Steelwork;
- Part 231, Application protocol: Process engineering data: Process design and process specification of major equipment;
- Part 232, Application protocol: Technical data packaging core information and exchange;
- Part 301, Abstract test suite: Explicit draughting;
- Part 302, Abstract test suite: Associative draughting;
- Part 303, Abstract test suite: Configuration controlled design;
- Part 304, Abstract test suite: Mechanical design using boundary representation;
- Part 305, Abstract test suite: Mechanical design using surface representation;
- Part 307, Abstract test suite: Sheet metal die planning and design;
- Part 308, Abstract test suite: Life cycle management - Change process;
- Part 309, Abstract test suite: Composite and metallic structural analysis and related design;
- Part 310, Abstract test suite: Electronic assembly, interconnect, and packaging design;
- Part 312, Abstract test suite: Electrotechnical design and installation;
- Part 313, Abstract test suite: Numerical control process plans for machined parts;
- Part 314, Abstract test suite: Core data for automotive mechanical design;
- Part 315, Abstract test suite: Ship arrangement;
- Part 316, Abstract test suite: Ship moulded forms;
- Part 317, Abstract test suite: Ship piping;
- Part 318, Abstract test suite: Ship structures;
- Part 320, Abstract test suite: Process planning, manufacture, and assembly of layered electronic products;
- Part 321, Abstract test suite: Functional data and their schematic representation for process plant;
- Part 322, Abstract test suite: Exchange of product data for composite structures;
- Part 323, Abstract test suite: Exchange of design and manufacturing product information for casting parts;

- Part 324, Abstract test suite: Mechanical product definition for process plans using machining features;
- Part 325, Abstract test suite: Building elements using explicit shape representation;
- Part 326, Abstract test suite: Ship mechanical systems;
- Part 327, Abstract test suite: Plant spatial configuration;
- Part 328, Abstract test suite: Building services: Heating, ventilation, and air conditioning;
- Part 329, Abstract test suite: Exchange of design and manufacturing product information for forged parts;
- Part 330, Abstract test suite: Building structural frame: Steelwork;
- Part 331, Abstract test suite: Process engineering data: Process design and process specification of major equipment;
- Part 332, Abstract test suite: Technical data packaging core information and exchange;
- Part 501, Application interpreted construct: Edge-based wireframe;
- Part 502, Application interpreted construct: Shell-based wireframe;
- Part 503, Application interpreted construct: Geometrically bounded 2D wireframe;
- Part 504, Application interpreted construct: Draughting annotation;
- Part 505, Application interpreted construct: Drawing structure and administration;
- Part 506, Application interpreted construct: Draughting elements;
- Part 507, Application interpreted construct: Geometrically bounded surface;
- Part 508, Application interpreted construct: Non-manifold surface;
- Part 509, Application interpreted construct: Manifold surface;
- Part 510, Application interpreted construct: Geometrically bounded wireframe;
- Part 511, Application interpreted construct: Topologically bounded surface;
- Part 512, Application interpreted construct: Faceted boundary representation;
- Part 513, Application interpreted construct: Elementary boundary representation;

- Part 514, Application interpreted construct: Advanced boundary representation;
- Part 515, Application interpreted construct: Constructive solid geometry;
- Part 517, Application interpreted construct: Mechanical design geometric presentation;
- Part 518, Application interpreted construct: Mechanical design shaded representation.

The structure of this International Standard is described in ISO 10303-1. The numbering of the parts of this International Standard reflects its structure:

- Parts 11 to 13 specify the description methods,
- Parts 21 to 26 specify the implementation methods,
- Parts 31 to 35 specify the conformance testing methodology and framework,
- Parts 41 to 49 specify the integrated generic resources,
- Parts 101 to 106 specify the integrated application resources,
- Parts 201 to 232 specify the application protocols,
- Parts 301 to 332 specify the abstract test suites, and
- Parts 501 to 518 specify the application interpreted constructs.

Should further parts of ISO 10303 be published, they will follow the same numbering pattern.

Annexes A, B, C, D, E and M are an integral part of this part of ISO 10303. Annexes F, G, H, J, K, L, and N are for information only.

Introduction

ISO 10303 is an International Standard for the computer-interpretable representation and exchange of product data. The objective is to provide a neutral mechanism capable of describing product data throughout the life cycle of a product independent from any particular system. The nature of this description makes it suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases and archiving.

This International Standard is organized as a series of parts, each published separately. The parts of ISO 10303 fall into one of the following series: description methods, integrated resources, application interpreted constructs, application protocols, abstract test suites, implementation methods, and conformance testing. The series are described in ISO 10303–1. This part of ISO 10303 is a member of the application protocols series. This part of ISO 10303 specifies an application protocol (AP) for the representation, exchange and sharing of functional and physical data created during the design stage of the process plant life-cycle.

This part of ISO 10303 is concerned with the functional and physical aspects of plant items, as shown in figure 1. As indicated by the figure, the different aspects of a plant item are relevant to different activities, but both aspects are described by the same documents, e.g., P&IDs, data sheets and their electronic equivalents.

NOTE – The physical aspect is also called 'material' in this part of ISO 10303. The word 'material' is used in the materials management or asset management sense, and means something physical that is identified and controlled.

The principal focus of this part of ISO 10303 is:

– the piping and instrumentation diagram (P&ID), e.g., the arrangement of ink on paper, or pixels on a screen;

– the information that can be understood from a P&ID, e.g., the identification, classification and connectivity of plant items;

– and property information about the plant items. This can be accessed using an intelligent P&ID system, but is traditionally presented on an equipment data sheet.

EXAMPLE 1 – A P&ID is shown in figure 2. This P&ID is described in annex L.

The data created during the detailed process engineering design stage of the process plant life-cycle is accessed and updated throughout the life of the plant. This part of ISO 10303 enables the exchange of the initial design data and the subsequent changes to this data. This part of ISO 10303 does not support the exchange of data such as operations and maintenance records that are created during construction and operation of a process plant.

This part of ISO 10303 enables the exchange of the following:

– a P&ID which is a drawing that presents information about the identification, class and connectivity of plant items in a way that can be understood by a human;

– the same information in an form that can be understood by a computer;

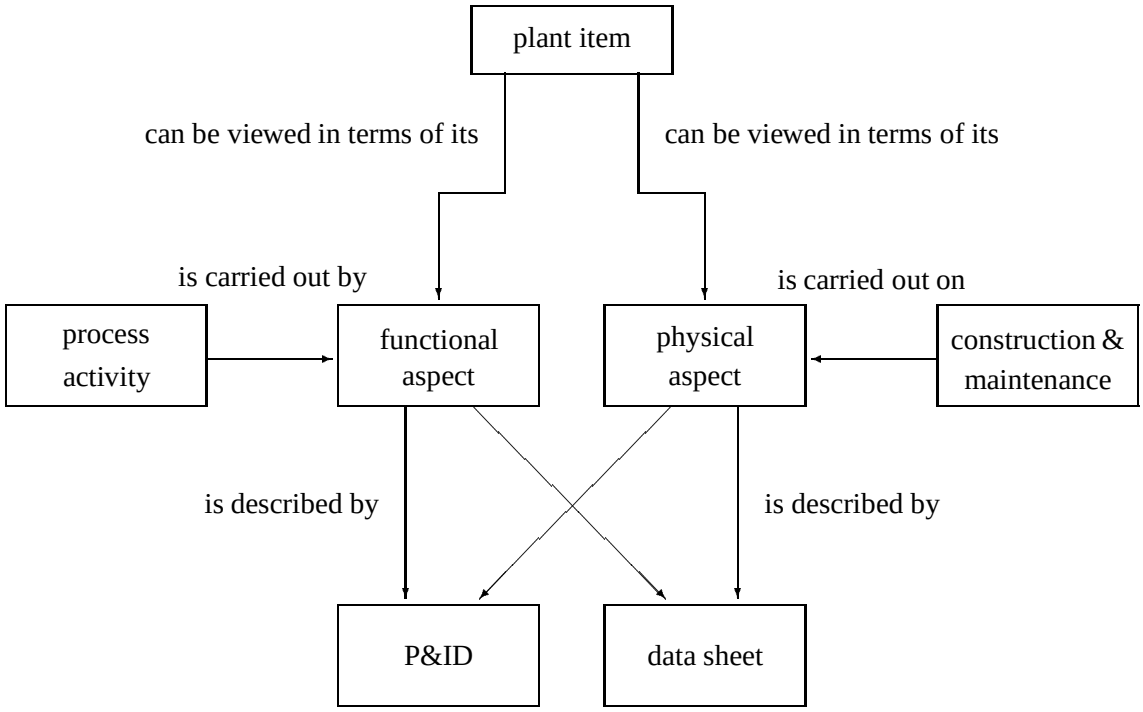

Figure 1 – Functional and physical aspects of a plant item

– information about the properties of plant items which are presented on data sheets in a traditional paper based system.

The exchange may be between process engineering design applications software, between process engineering design data bases, or between applications software and a data base.

This part of ISO 10303 supports the exchange of design 'snapshots' that are the electronic equivalent of traditional exchanges of paper P&IDs and data sheets. This part of ISO 10303 also enables the exchange of a history of design changes, and of audit trail and approval data associated with data objects within the design.

This part of ISO 10303 supports the exchange of class libraries. A class library is a collection of inter-related classes, or a taxonomy, that can be used to convey information about the nature of plant items and the properties that are valid for them. A class library can contain classes that are specified by this part of ISO 10303 and user defined classes which are specialisations of them. A class library can be exchanged along with a design that contains the classified plant items, or sent on its own by a customer to a contractor to specify the classes that shall be used.

This part of ISO 10303 supports the identification of a class that is defined by ISO 13584. This enables further information about a class to be obtained from an implementation of ISO 13584.

This part of ISO 10303 supports the exchange of standard parts catalogues. A standard parts catalogue is

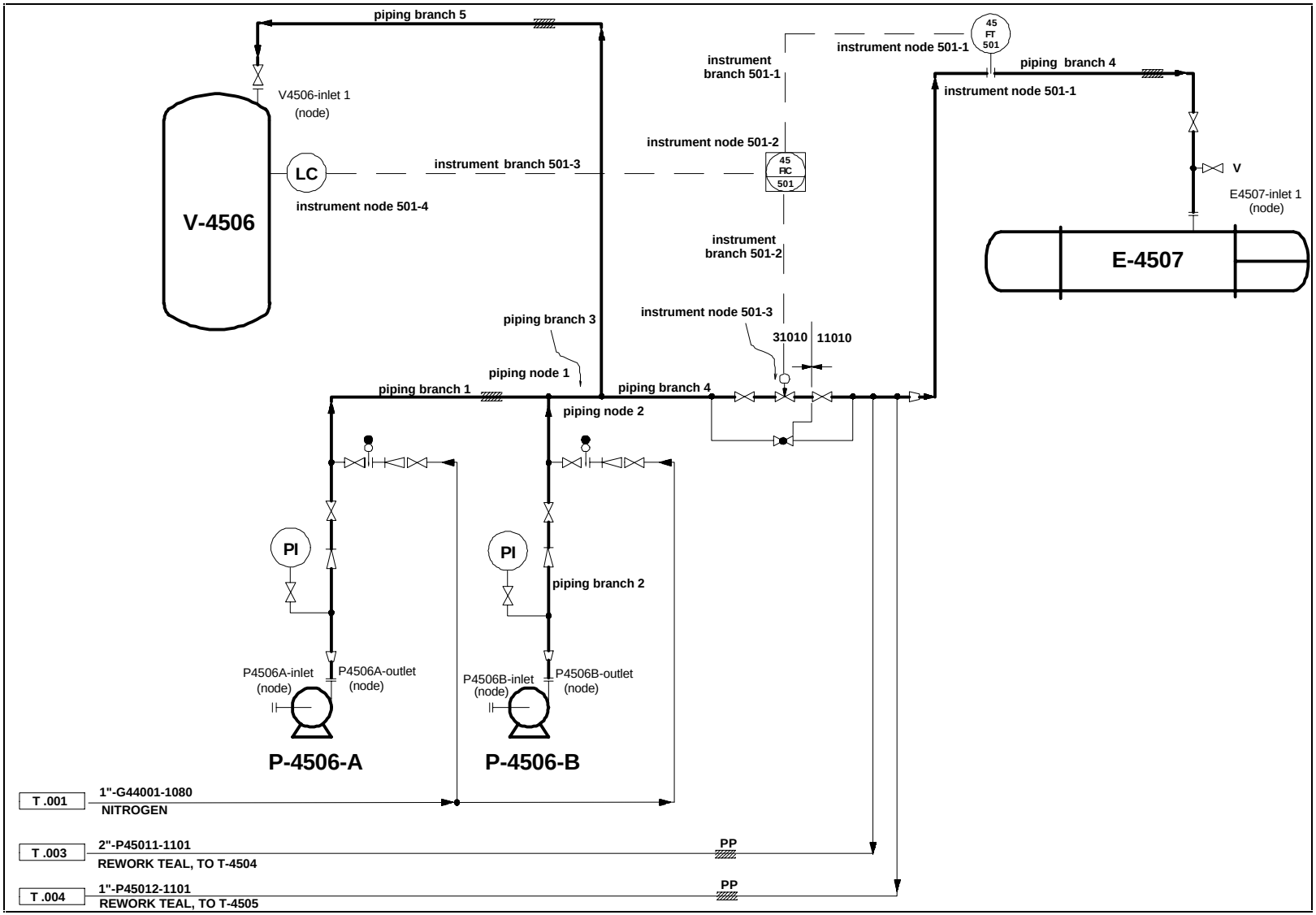

Figure 2 – Example of a P&ID for a petro-chemical plant system

a collection of reference part definitions, such that a specific instance corresponding to each definition can be supplied as required. Specific instances of items within a process plant can be defined by reference to a standard parts catalogue. A standard parts catalogue can be exchanged along with a design that contains the specific instances , or sent on its own by a customer to a contractor to specify the standard parts that shall be used.

This part of ISO 10303 supports the identification of a standard part that is defined by ISO 13584. This enables further information about a standard part to be obtained from an implementation of ISO 13584.

NOTE 1 – The difference between the intended use of a class library and a standard parts catalogue is as follows:

– A class library records knowledge about the nature of things. For each class within the library there may be many different objects with different properties that are members. The definition of a class makes it possible to judge whether an object is member or not.

  A class library can be a record of knowledge about the nature of things that is shared by both parties to an exchange. For a standard class, such as 'centrifugal_pump', the knowledge is provided by this part of ISO 10303 in the tables of standard instances.

– A parts catalogue records the definitions of reference parts. For each standard part within the catalogue there may be many specific instances, but they each have the same properties to within a tolerance.

  A standard parts catalogue can be knowledge that is transferred by an exchange. The definition of a reference part that is not known to the receiver can refer to a class that is known to the receiver. Hence the classification of a standard part as a 'centrifugal_pump', conveys knowledge about that standard part to the receiver.

This part of ISO 10303 supports the exchange of a specification of properties that plant items are required to have for a particular design activity. This is the electronic equivalent of a blank data sheet.

Figure 3 is a data planning model for this part of ISO 10303 which shows the principal application objects.

The concepts shown in figure 3 are as follows:

facility: the functional aspect of a plant item which is relevant to the process activities carried out by a process plant;

material: the physical aspect of a plant item which is relevant to the mechanical design, construction and maintenance of a process plant;

activity: the operations that are carried out upon process materials;

property: a quantity which is observable or measurable when a process plant has been constructed and is being operated, and which are deemed or predicted when a process plant is being designed;

class of facility: a class that indicates the functional nature of a plant item;

class of material: a class that indicates the physical nature of a plant item;

class of property: a class that indicates the nature of an observable or measurable quantity.

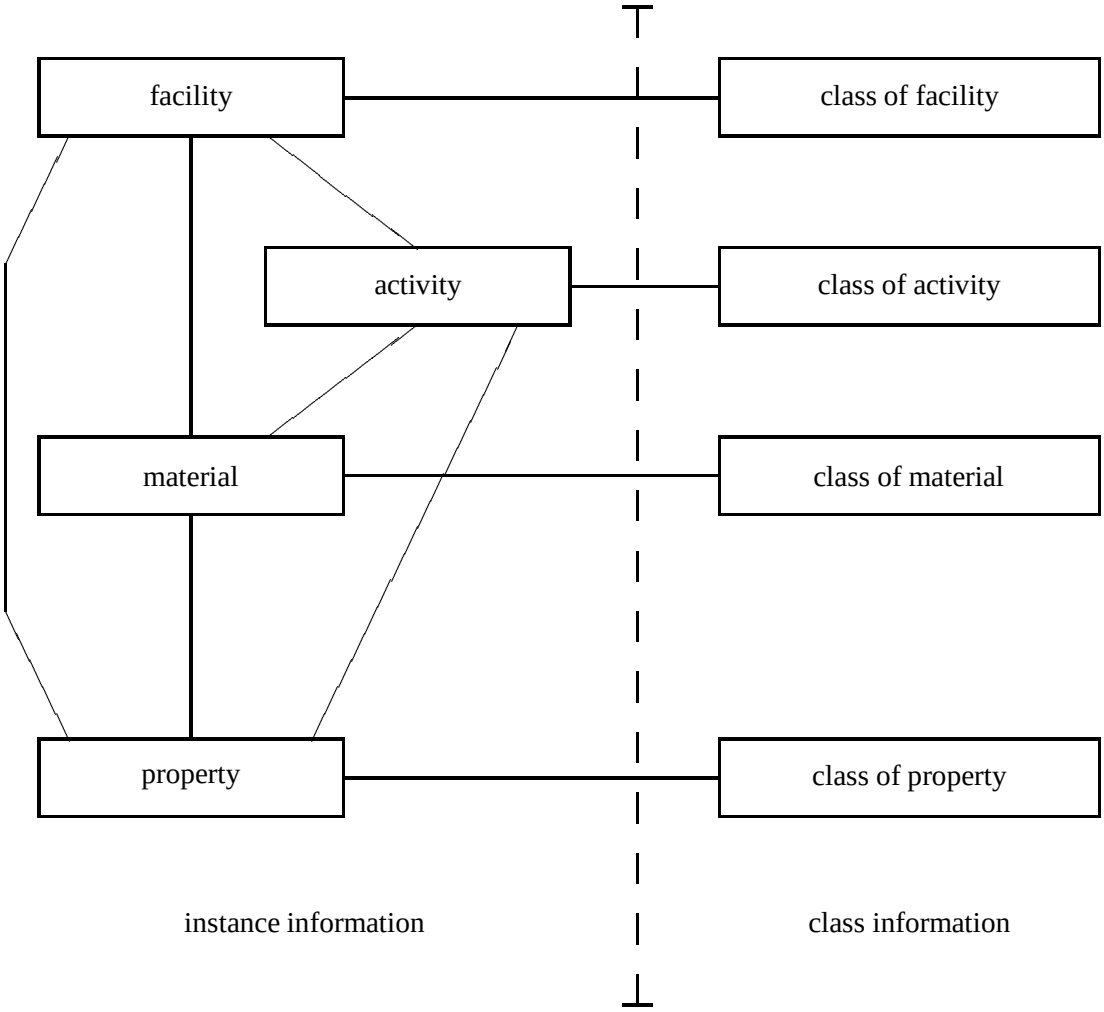

Figure 3 – Data planning model showing principal objects and their classification

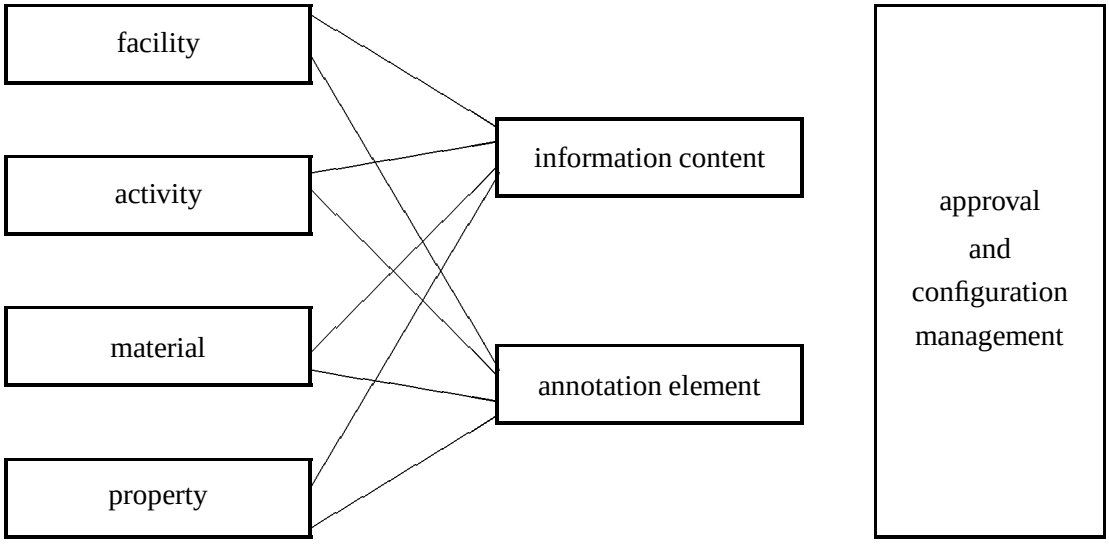

Figure 4 – Data planning model showing description, presentation and configuration management

NOTE 2 – All the concepts shown in figure 3 correspond directly to application objects defined in clause 4.2 of this part of ISO 10303.

All the principal concepts shown in figure 3 can be described, presented by a schematic drawing, and subjected to configuration management and approval. This is shown in figure 4.

The concepts introduced in figure 4 are as follows:

annotation element: a graphical symbol, textual annotation or curve on a schematic drawing that presents information;

information content: a text string, number, or the contents of a document;

Any object can be identified or described by a text string.

A property can be described by a numeric information content which is its value with respect to a unit of measure.

approval and configuration management: a specification of the version sequence and approval status for all application objects.

NOTE 3 – The concepts annotation element and information content each correspond directly to application objects defined in clause 4.2 of this part of ISO 10303.

The approval and configuration management capability is provided by the Units of Functionality variance-

and derivation and approval.

This part of ISO 10303 does not cover the spatial arrangements of plant items within a process plant. Data exchange for activities that involve both functional and spatial data, may require the co-operative use of this part of ISO 10303 with ISO 10303 part 227 “Application protocol: Plant spatial configuration”.

This part of ISO 10303 does not cover the simulation of process activities carried out by a process plant. Data exchanges for activities that involve both functional and process simulation data, may require the co-operative use of this part of ISO 10303 with ISO 10303 part 231 “Application protocol: Process engineering data: Process design and process specification of major equipment”.

Application protocols provide the basis for developing implementations of ISO 10303 and abstract test suites for the conformance testing of AP implementations.

Clause 1 defines the scope of the application protocol and summarizes the functionality and data covered by the AP. Clause 3 lists the words defined in this part of ISO 10303 and gives pointers to words defined elsewhere. An application activity model that is the basis for the definition of the scope is provided in annex F. The information requirements of the application are specified in clause 4 using terminology appropriate to the application. A graphical representation of the information requirements, referred to as the application reference model, is given in annex G.

Resource constructs are interpreted to meet the information requirements. This interpretation produces the application interpreted model (AIM). This interpretation, given in 5.1, shows the correspondence between the information requirements and the AIM. The short listing of the AIM specifies the interface to the integrated resources and is given in 5.2. Note that the definitions and EXPRESS provided in the integrated resources for constructs used in the AIM may include select list items and subtypes which are not imported into the AIM. The expanded listing given in annex A contains the complete EXPRESS for the AIM without annotation. A graphical representation of the AIM is given in annex H. Additional requirements for specific implementation methods are given in annex D.

Industrial automation systems and integration — Product data representation and exchange — Part 221 : Application protocol: Functional data and their schematic representation for process plant

1 Scope

This part of ISO 10303 specifies the use of the integrated resources necessary for the scope and information requirements for functional data and their schematic representation for process plant.

NOTE 1 – The application activity model in annex F provides a graphical representation of the processes and information flows which are the basis for the definition of the scope of this part of ISO 10303.

This part of ISO 10303 specifies information about intended (see 3.5.15) plant systems (see 3.5.22) and equipment (see 3.5.10) created during the detailed design of a process plant (see 3.5.20), and information about actual (see 3.5.1) plant systems and equipment created during the construction, operation and decomissioning of a process plant.

NOTE 2 – All the information in the scope of this part of ISO 10303 may be created during the detailed design of a process plant. However, the changes to the information during later stages of the process plant life-cycle are also within scope.

Three categories of information are defined in clause 6 'Conformance requirements'. These categories of information correspond to major information flows within the application activity model in annex F as follows:

basic functional data: This category of information supports the exchange of equipment characteristics (see F.1.43) and equipment lists (see F.1.45).

schematic presentation: This category supports the exchange of schematic diagrams in general (see F.1.125) and piping and instrumentation diagrams in particular (see F.1.82).

business information: This category supports the exchange of engineering design, construction and operation changes (see F.1.41), and change requests (see F.1.9).

The following are within the scope of this part of ISO 10303:

- identification of systems and equipment that carry out process activities (see 3.5.24) within a process plant, or that control the carrying out of process activities within a process plant;
- connectivity of plant systems and equipment;
- classification of plant systems and equipment;

NOTES

3 – Plant systems and equipment may be classified on the basis of their functional and physical aspects.

4 – The three items listed above are information that is shown on a schematic presentation (see 3.5.28) such as a P&ID or a PFD.

5 – The classification shown on a schematic presentation is limited in detail. Further detail is provided in text form within documents such as data sheets. The standard functional and physical classes within this part of ISO 10303 provide more detail than is normally shown on a schematic presentation.

– definnition of standard functional (see 3.5.11) and physical (see 3.5.17) classes (see 3.5.4) of the following:

  - process plants and plant systems;
  - piping and protection material, including coating and insulation (see 3.5.14);
  - heat transfer equipment items and their components;
  - valves and their components;
  - rotating equipment items and their components;
  - vessels and their components;
  - instrumentation (see 3.5.13) items and their components.

– user defined functional and physical classes of plant systems and equipment, and user defined classes of property.

NOTE 6 – User defined classes can do the following:

- add further detail to the standard classification;
- provide classification that extends the scope of this part of ISO 10303 to include other classes of systems and equipment.

– composition of plant systems and equipment;

– association between the functional definition of a plant system or equipment and the physical plant items (see 3.5.21) which provide the service;

– functional and physical properties of plant systems and equipment;

NOTES

7 – Functional and physical property data may be shown on a P&ID. An intelligent P&ID system uses the P&ID as a graphical user interface to functional and physical property data.

8 – Functional and physical property data are presented on a data sheet.

- definition of standard classes of property for plant systems and equipment;
- presentation of as a P&ID of identification, connectivity, classification and property information about plant systems and equipment;
- user defined classes of symbols;
- presentation of a P&ID as a document or graphical display;
- library of functional and physical classes for plant systems and equipment;

NOTE 9 – This part of ISO 10303 supports the exchange of a class library with or without plant items that are classified. A class library can be sent on its own from a customer to a contractor to specify the classes that shall be used to indicate the nature of plant items within a design.

- library of classes for properties;
- specification of those classes of property for which a value is required for a particular design activity;

NOTE 10 – This part of ISO 10303 supports the exchange of a request for property values.

- external references to classes that are stored in accordance with ISO 13584;
- catalogue (see 3.5.3) of standard parts;

NOTE 11 – This part of ISO 10303 supports the exchange of a catalogue of standard parts with or without specific instances of objects that are derived from the typical instances of objects in the catalogue.

- external references to standard parts that are stored in accordance with ISO 13584;
- change information;

NOTE 12 – This part of ISO 10303 supports the association of any data with a previous version.

- piping specification;
- audit trail and approval;

NOTE 13 – This part of ISO 10303 supports the association of any data with its creator, and a time and date of creation. Any data may be associated with an approval status.

- references to documents that describe plant items;

EXAMPLE 2 – Data sheet, P&ID and safety case report are all classes of document.

NOTES

14 – A document that is referenced can be in either paper or electronic form.

15 – This part of ISO 10303 supports the association of a document with approval status.

– process material (see 3.5.26) and substance;

– identification and description of construction material (see 3.5.8);

– identification and textual description of the position and orientation of plant systems and equipment.

NOTE 16 – The computer understandable description of position and orientation with respect to a co-ordinate system is within the scope of ISO 10303 part 227.

The following are outside the scope of this part of ISO 10303:

– description of the shape, position and orientation of plant systems and equipment using geometric models;

NOTE 17 – This is within the scope of ISO 10303 part 227.

– the simulation of processes or operations performed by plant systems and equipment;

NOTE 18 – This is within the scope of ISO 10303 part 231.

– document structure information, such as is provided by SGML;

– document presentation information, such as provided by LaTeX or HTML;

NOTE 19 – Document presentation information can specify how property values are presented to a human as a data sheet.

– composition and processing history of construction material;

– contracts and other business relationships and activities.

– standard classes for the following:

  - civil and structural items and their components;
  - electrical systems, electrical equipment items and their components;
  - mechanical handling and movement systems, such as conveyor belts and cranes, and their components;
  - construction materials;

- HVAC systems and their components;
- process activities including control processes;
- P&ID symbols.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 10303. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 10303 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 31:1994, *Quantities and Units.*

ISO 1000:1992, *SI units and recommendations for the use of their multiples and of certain other units.*

ISO 1998-1:1974, *Petroleum industry — Vocabulary — Part 1: Trilingual edition.*

ISO 1998-1 DAM 1:1985, *Petroleum industry — Vocabulary — Part 1: amendment 1.*

ISO 1998-1:1976, *Petroleum industry — Vocabulary — Part 2: Trilingual edition.*

ISO 1998-1 DAM 1:1985, *Petroleum industry — Vocabulary — Part 2: amendment 1.*

ISO 8824-1:1994, *Information Technology — Open System Interconnection — Abstract Syntax Notation One (ASN.1) — Part 1: Specification of Basic Notation.*

ISO 10303-1:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 1 : Overview and fundamental principles.*

ISO 10303-11:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 11 : Description method: The EXPRESS language reference manual.*

ISO 10303-21:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 21 : Implementation method: Clear text encoding of the exchange structure.*

ISO 10303-31:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 31 : Conformance testing methodology and framework: General concepts.*

ISO TC184/SC4 N539, *Industrial automation systems and integration — Product data representation and exchange — Part 41 : Integrated generic resource: Fundamentals of product description and support (Revision of ISO 10303-41:1994).*

ISO 10303-42:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 42 : Integrated generic resource: Geometric and topological representation.*

ISO 10303-43:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 43 : Integrated generic resource: Representation structures.*

ISO 10303-44:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 44 : Integrated generic resource: Product structure configuration.*

ISO 10303-45:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 45 : Integrated generic resource: Materials.*

ISO 10303-46:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 46 : Integrated generic resource: Visual presentation.*

ISO 10303-49:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 49 : Integrated generic resource: Process structure and properties.*

ISO 10303-101:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 101 : Integrated application resource: Draughting.*

ISO 10303-227:—,[1)] *Industrial automation systems and integration — Product data representation and exchange — Part 227: Application protocol: Plant spatial configuration.*

ISO 13584-1:—[1)], *Industrial automation systems and integration — Parts Library — Part 1 : Overview and fundamental Principles.*

ISO 13584-42:—[1)], *Industrial automation systems and integration — Parts Library — Part 42 : Methodology for Structuring Part Families.*

3 Definitions and abbreviations

For the purposes of this International Standard, the following definitions and abbreviations apply:

3.1 Terms defined in ISO 10303-1

This part of ISO 10303 makes use of the following terms defined in ISO 10303-1:1994:

- abstract test suite (ATS);
- application;
- application activity model (AAM);

[1)] To be published.

- application interpreted model (AIM);
- application protocol (AP);
- application reference model (ARM);
- conformance class;
- conformance testing;
- implementation method;
- integrated resource;
- protocol information and conformance statement (PICS);
- unit of functionality (UoF).

3.2 Terms defined in ISO 10303-31

This part of ISO 10303 makes use of the following terms defined in ISO 10303-31:1994:

- conformance class;

3.3 Terms defined in ISO 10303-42

This part of ISO 10303 makes use of the following terms defined in ISO 10303-42:1994:

- closed curve;
- curve;
- placement coordinate system;
- surface;
- topological sense;

3.4 Terms defined in ISO 10303-46

This part of ISO 10303 makes use of the following terms defined in ISO 10303-31:1994:

- layer;

3.5 Other definitions

For the purposes of this part of ISO 10303, the following definitions apply.

3.5.1 actual: an indication that a physical or functional thing has an existence at some time in the real world.

An actual plant item (see 3.5.21) has properties that can be measured or observed. An intended plant item has properties that are deemed by a design activity, calculated by a simulation or analysis activity, or guessed.

NOTES

1 – Within the scope of this part of ISO 10303, being actual can be specified for a thing that is:

- a plant item;
- an association between plant items such as a connection or composition;
- an activity or an associations between a plant item and an activity;
- a possession of a property by a plant item or activity.

The full list of Application Objects that can be specified to be actual is given in 4.2.105.

2 – A thing cannot be both actual and intended (see 3.5.15).

An actual thing can be the realisation of an intended thing (see 4.2.140).

3.5.2 assembly: a set of things which have a relationship to each other apart from being members of the same set.

NOTES

1 – Within the scope of this part of ISO 10303, an assembly can be of things that are:

- plant items (see 3.5.21);
- lines, symbols or textual annotation on a schematic presentation (see 3.5.28).

2 – A set of things which do not have a relationship with each other, apart from being members of the same set, is a collection (see 3.5.5).

3 – A plant item (see 3.5.21) can be an assembly of other plant items. A pump is an assembly that contains, amongst other things, a body and an impeller.

3.5.3 catalogue: a collection (see 3.5.5) of things that exists to support a selection activity.

The term is also used for a paper or electronic document that holds information about a collection of things.

NOTES

1 – Within the scope of this part of ISO 10303, a catalogue can be of things that are:

– plant items (see 3.5.21);

– symbols on a schematic presentation (see 3.5.28).

2 – A catalogue can be a collection of typical, or reference, symbols from which the definition of a specific occurrence of a symbol in a schematic presentation (see 3.5.28) can be selected.

3 – A catalogue can be a collection of typical, or reference, plant items (see 3.5.21) from which the definition of a specific occurrence of a plant item in the design of a process plant (see 3.5.20) can be selected.

3.5.4 class: a concept that can be used to separate things into those which are of the class and those which are not.

A class has a criterion for inclusion that is not merely an enumeration of its members.

NOTES

1 – Within the scope of this part of ISO 10303, a class can be specified for a thing that is:

– a plant item (see 3.5.21);

– a line, symbol or textual annotation on a schematic presentation (see 3.5.28);

– a property;

– an activity;

– an information holder (see 3.5.12);

– a text;

– a role that is played by a plant item in an activity.

2 – This part of ISO 10303 specifies standard classes of plant item (see 3.5.21), property and activity, and provides a capability for the exchange and sharing of extensions to this standard set.

3.5.5 collection: a set of things which do not have any relationship to each other apart from being members of the same set.

NOTES

1 – Within the scope of this part of ISO 10303, an collection can be of things that are:

– plant items (see 3.5.21);

– lines, symbols or textual annotation on a schematic presentation (see 3.5.28);

– classes (see 3.5.4).

2 – A set of things which have a relationship with each other, apart from being members of the same set, is an assembly (see 3.5.2).

3 – A Bill of Materials (BoM) is a collection of specific occurrences of plant items.

EXAMPLE 3 – The catalogue of typical or reference plant items (see 3.5.21) that is issued by J. Bloggs and Co. piping component manufacturers, is a collection.

3.5.6 component: a part of another thing.

NOTES

1 – Within the scope of this part of ISO 10303, a thing that is a component can be:

– a part of a functional (see 3.5.11) or physical (see 3.5.17) plant item (see 3.5.21);

– a parts of a process material (see 3.5.26) that is a mixture.

2 – A thing that contains a component can be either an assembly (see 3.5.2) or a collection (see 3.5.5).

3 – A component can itself have components.

3.5.7 connection: an association between two things that enables the flow of material, energy, mechanical load or information between them or constrains their relative positions.

NOTES

1 – Within the scope of this part of ISO 10303, a connected thing can be either functional (see 3.5.11) or physical (see 3.5.17) plant items (see 3.5.21).

2 – A connection can be the result of a physical (see 3.5.17) joining.

3 – A functional (see 3.5.11) connection can exist between two things without a physical joining.

3.5.8 construction material: a class (see 3.5.4) of a quantity of matter that indicates the substance from which it is made; the complete processing history of that substance from raw material to finished product; and the expected material properties the quantity of matter.

3.5.9 data context object: an object that has a description given by some data records within a repository but not others.

NOTE – The set of records that forms the description is the relevant data (see 3.5.27) for the data context object.

3.5.10 equipment: a plant item (see 3.5.21 that can be installed to perform a service and that is treated as a single item for the purpose of design, acquisition or operation.

3.5.11 functional: an indication that a thing is concerned with the actions or activities that a plant item (see 3.5.21) performs or is capable of performing.

NOTES

1 – Within the scope of this part of ISO 10303, being functional can be specified for a thing that is:

- a property possessed by a plant item (see 3.5.21);
- an association between plant items such as a connection or composition;

2 – A thing concerned with existence as a volume or matter or space, rather than function, is described as physical (see 3.5.17).

3 – Operating temperature and operating pressure are functional properties.

3.5.12 information holder: a functional (see 3.5.11) or physical (see 3.5.17) object that is, or can be, used to store data

EXAMPLES

4 – The computer file with name 'mbb_scr_12345.tex', that is on the project data base, is a functional information holder.

5 – The paper document with reference 'MBB/SCR/12345', that is held in the company archive, is a physical information holder.

3.5.13 instrument: a plant item (see 3.5.21) that controls or monitors a process plant (see 3.5.20) or contributes to the control and monitoring as part of an assembly (see 3.5.2).

EXAMPLE 6 – Control valve, sensor, and gauge are classes of instrument.

3.5.14 insulation: a quantity of matter or space that provides resistance to the flow of heat, electricity, sound or mechanical vibration.

3.5.15 intended: an indication that a thing is an intention rather that something that has an existence at some time in the real world.

NOTES

1 – Within the scope of this part of ISO 10303, being intended can be specified for a thing that is:

- a plant item;
- an association between plant items such as a connection or composition;
- an activity or an associations between a plant item and an activity;

– a possession of a property by a plant item or activity.

The full list of things that can be specified to be intended is given in 4.2.105.

2 – An intended thing can be realised by an actual (see 3.5.1) thing.

3 – An intended plant item (see 3.5.21) has properties that are deemed by a design activity, calculated by a simulation or analysis activity, or guessed. An actual plant item has properties that can be measured or observed.

3.5.16 material stream: The meaning is one of the following:

a) a quantity of process material (see 3.5.26) in motion; or

b) a flow of process material across a surface (see 3.3).

Where a transportation activity is idealised as being along a one dimensional path then a flow of process material across a surface is idealised as being at a point in the path.

NOTES

1 – Each usage of the term material stream within this part of ISO 10303 is qualified to indicate the meaning that is intended.

2 – The volume of material in motion within a pipeline at an instance can be called a material stream.

3.5.17 physical: an indication that a thing is concerned with the physical existence of a plant item (see 3.5.21) as a volume of matter and space.

NOTES

1 – Within the scope of this part of ISO 10303, being physical can be specified for a thing that is:

– a property possessed by a plant item (see 3.5.21);

– an association between plant items such as a connection or composition;

2 – A thing concerned with the activities or processes that a plant item performs or is capable of performing, rather than its existence as a volume of matter or space, is described as functional (see 3.5.11).

EXAMPLE 7 – Position, orientation, size and mass are classes of physical property.

3.5.18 pipe: a plant item (see 3.5.21) that is hollow and approximately cylindrical, that can have a constant cross-section along its length, and that conveys fluid, vapour, or particulate matter.

EXAMPLE 8 – Duct D-4507 that is part of the HVAC system for Much Binding B, has a rectangular cross section, and is not a pipe.

3.5.19 piping and instrumentation diagram (P&ID): a schematic presentation (see 3.5.28) of information that consists of at least the following:

– the nature or class (see 3.5.4) plant items (see 3.5.21)

– the functional (see 3.5.11) connection (see 3.5.7) and assembly (see 3.5.2) of plant items;

– the identification of principal plant items.

It can also present the following;

– the functional properties of plant items;

– the physical properties of plant items.

3.5.20 process plant: an assembly (see 3.5.2) of one or more plant systems (see 3.5.22) and plant items (see 3.5.21) that can, or is intended to perform a chemical, physical or transport process. A process plant is identified as a single unit for the purposes of management and ownership. A process plant has both physical (see 3.5.17) and functional (see 3.5.11) aspects.

3.5.21 plant item: a quantity of matter or space that is, or is intended to be, a part of a process plant (see 3.5.20).

A plant item has both physical (see 3.5.17) and functional (see 3.5.11) aspects.

NOTE – A plant item that is a volume of space can contain material objects but need not.

3.5.22 plant system: a functional (see 3.5.11) assembly (see 3.5.2) of plant items (see 3.5.21) with functional relationships between the parts that performs or can perform a clearly identified activity as a whole.

3.5.23 presentation: a quantity of matter that holds information in a form that can be understood by a person.

NOTE – A P&ID is a presentation of information about plant items (see 3.5.21) and their connectivity.

3.5.24 process activity: an activity that transforms or transports process material (see 3.5.26) between its input to a process plant as feed stock and its output from a process plant as product or waste.

NOTE – A transformation can be a change of physical state, a physical separation or mixing, or a biological or chemical process.

3.5.25 process flow diagram (PFD): a schematic presentation (see 3.5.28) of information that consists of at least:

– the nature or class (see 3.5.4) of process activities (see 3.5.24);

– the connection of process activities by material streams (see 3.5.16);

– the plant items (see 3.5.21) that perform the process activities and their identification.

It can also present the following:

– the properties of the process activities and the material streams for particular cases;

– the measurements that are made upon process activities and material streams;

– the flow of signal between sensors, controllers, and actuators;

– the control logic that is implemented by a controller.

NOTE – The process activities shown on a PFD can be called 'unit operations'.

3.5.26 process material: a quantity of matter that is transformed or transported by a process activity (see 3.5.24).

EXAMPLE 9 – Cooling water and air are classes of process material.

3.5.27 relevant data: a set of data records that forms part of the description of an object.

NOTE – A set of data records can contain the description of two versions of a plant item. Some of the data records can be within the relevant data for one version, and some of the data records can be within the relevant data for the other version.

Some data records can be within the relevant data for both versions.

Each version of the plant item is a data context object (see 3.5.9).

3.5.28 schematic presentation: a presentation (see 3.5.23) that conveys information about relationships between things by the relative physical position of symbols.

NOTES

1 – Within the scope of this part of ISO 10303, a presentation can be of things that are plant items (see 3.5.21).

2 – The relative physical position of symbols in a schematic presentation does not necessarily convey any information about the physical position of things.

3.5.29 site: a part of the earth's surface, that can be either land or sea bed.

NOTE – A process plant (see 3.5.20) can be built on some sites.

3.5.30 specific: an indication that an object has a unique existence, or is the intention for an object that can have a unique existence.

NOTES

1 – An object is either specific or typical (see 3.5.31).

2 – An actual (see 3.5.1) plant item (see 3.5.21 in an actual process plant (see 3.5.20) is a specific object.

3.5.31 typical: an indication that an object is the embodiment of the shared aspect of a family of similar objects.

NOTES

1 – An object is either typical or specific (see 3.5.30).

2 – A typical object can be a reference design from which one or more intended (see 3.5.15) physical (see 3.5.17) objects are derived by a design process.

3 – A typical object can be a reference design from which one or more actual (see 3.5.1) physical (see 3.5.17) objects are derived by a manufacturing process.

EXAMPLE 10 – Each item shown in the catalogue of pipe fittings supplied by J. Bloggs and Co. is a typical object.

3.6 Abbreviations

For the purposes of this part of ISO 10303, the following abbreviations apply.

AA	Application Assertion
AAM	Application Activity Model
AIC	Application Interpreted Construct
AIM	Application Interpreted Model
AO	Application Object
AP	Application Protocol
ARM	Application Reference Model
ASCII	American Standard Code for Information Interchange
ATS	Abstract Test Suite
BoM	Bill of Materials
DAM	Draft AMendment

GIF	Graphics Interchange Format
HTML	HyperText Markup Language
HVAC	Heating, Ventilation and Air Conditioning
NPSH	Net Positive Suction Head
NPSHR	Net Positive Suction Head Ratio
P&I	Piping and Instrumentation
P&ID	Piping and Instrumentation Diagram
PFD	Process Flow Diagram
PICS	Protocol Implementation Conformance Statement
SGML	Standard Generalised Markup Language
UoF	Unit of Functionality

4 Information requirements

This clause specifies the information required for functional data and their schematic representation for process plant

The information requirements are specified as a set of units of functionality, application objects, and application assertions. These assertions pertain to individual application objects and to relationships between application objects. The information requirements are defined using the terminology of the subject area of this application protocol.

NOTES

1 – A graphical representation of the information requirements is given in annex G.

2 – The information requirements correspond to those of the activities identified as being within the scope of this application protocol in annex F.

3 – The mapping table specified in 5.1 shows how the integrated resources and application interpreted constructs are used to meet the information requirements of this application protocol.

4.1 Units of functionality

This subclause specifies the units of functionality for the Functional data and their schematic representation for process plant application protocol. This part of ISO 10303 specifies the following units of

functionality:

- activity;
- administration;
- approval;
- catalogue_of_standard_items;
- classification_of_plant_item;
- composition_and_connection_of_plant_item;
- data_inheritance;
- effect;
- hierarchical_decomposition;
- identification;
- information_and_document;
- involvement_constraint;
- library_of_classes;
- life_cycle;
- plant_item;
- position_and_orientation;
- process_material_and_substance;
- property;
- required_information;
- schematic_appearance;
- schematic_presentation_and_layout;
- variance_and_derivation.

The units of functionality and a description of the functions that each UoF supports are given below. The application objects included in the UoFs are defined in 4.2.

NOTE 1 – The UoFs within this part of ISO 10303 are divided into two groups:

engineering content UoFs: These UoFs are determined by the engineering content of process plant functional data;

The UoFs within this group are activity, catalogue, classification_of_plant_item, composition_and_connection_of_plant_item, hierarchical_decomposition, involvement_constraint, library_of_classes, plant_item, position_and_orientation, process_material_and_substance, property, and required_information.

These UoFs have specific relationships between them that are determined by their engineering content;

business practice UoFs: These UoFs are determined by the business practices concerned with the management of process plant functional data and its presentation.

UoFs within this group are administration, approval, data_inheritance, effect, identification, information_and_document, life_cycle, schematic_appearance, schematic_presentation_and_layout, and variance_and_derivation.

These UoFs provide generic facilities and can be used in conjunction with many other UoFs.

An outline of the relationships between UoFs is shown in figure 5. This diagram shows the principal references between UoFs, and provides a guide to the reader of this part of ISO 10303.

The notation for this figure is as follows:

- The boxes present UoFs.
- The lines indicate references between UoFs, with the circle at the referenced UoF.
- The UoFs that support business practices, and that are not determined by engineering content, are shown referencing a thick black line to indicate that they can reference many of the other UoFs.

The lines between the business practice UoFs and the engineering content UoFs indicate specific relationships as follows:

information_and_document to plant_item: The information_and_document UoF can be used to hold information about any application object. The line shown in figure 5 indicates that a document or computer file is itself a plant_item.

effect to activity: The effect UoF can hold information about the beginning or end of any application object. The line shown in figure 5 indicates that an activity can be recorded as the cause of an effect.

approval to activity: The approval UoF can hold information about the approval of any application object. The line shown in figure 5 indicates that an activity can be recorded as the purpose for which approval is given.

This part of ISO 10303 specifies the application objects within each UoF, and also standard instances of application objects.

A standard instance of an application object is an instance that has a meaning completely defined by this part of ISO 10303.

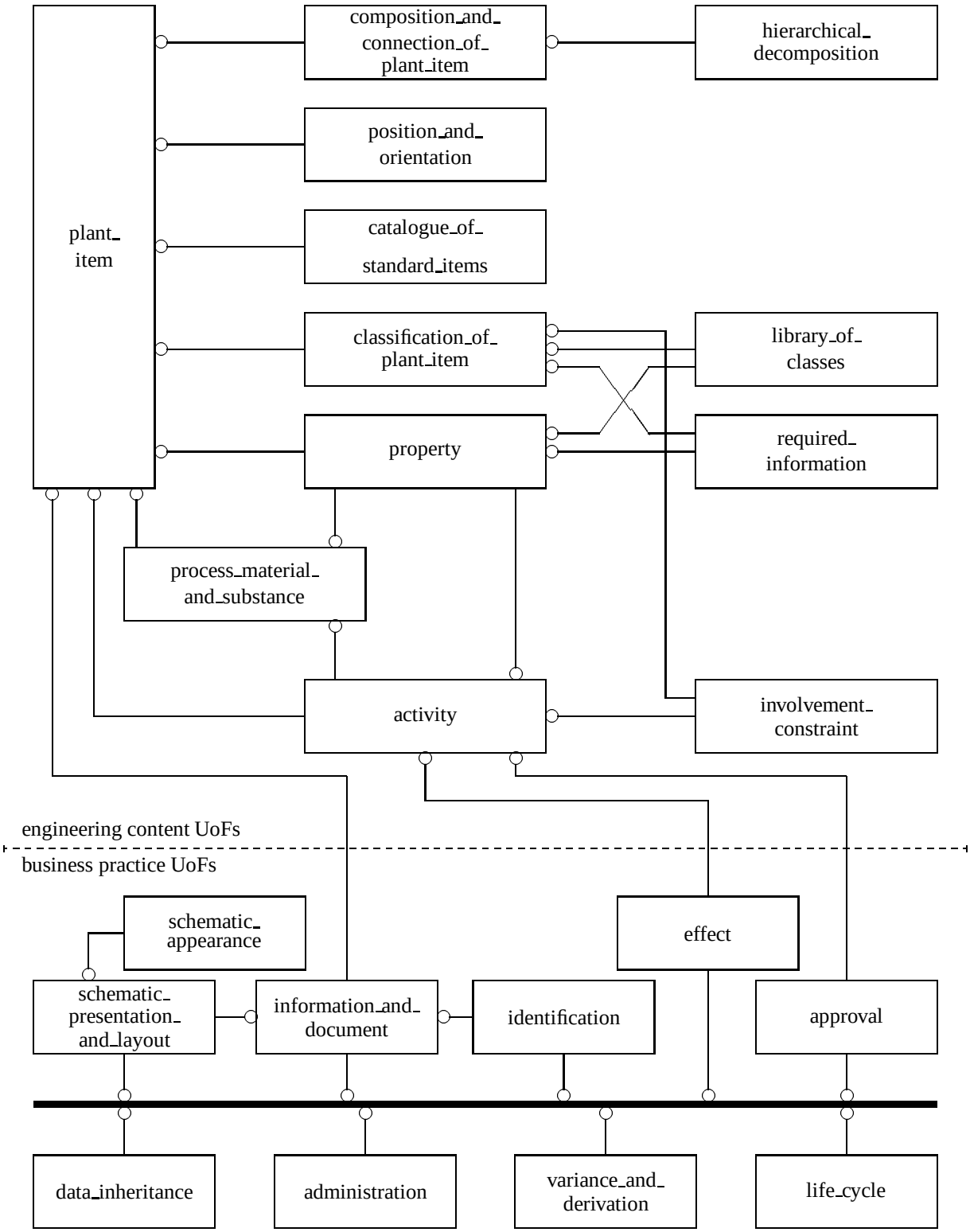

Figure 5 – Outline of the references between UoFs

NOTE 2 – A thing that exists in the real world can be recorded by an instance of an application object. Instances are created by a user of this part of ISO 10303 as required to record the existence of things. A standard instance is one for which this part of ISO 10303 specifies the thing that is recorded.

This part of ISO 10303 provides the ability to exchange or share information about the classification of an application object. An instance of an application object is classified by being associated with another application object that is a class.

NOTE 3 – Application objects are often classified by being associated with an instance of a class that is held in a class library. A class library can contain standard instances that are common classes (such as Pipe or Heat_exchanger_system), as well as user defined instances that are specialised classes.

EXAMPLE 11 – Equipment item P-4506-A in annex L is classified as a pump.

NOTE 4 – A thing can be classified in many ways. The plant item in example 11 can also be classified as a centrifugal_pump and a pressure_part.

A class may be defined within this part of ISO 10303, or may be defined by a user.

EXAMPLE 12 – Coal_pulveriser is a functional class of plant item that is not defined within this part of ISO 10303, but can be defined by a user.

NOTES

5 – Information about a class and information about a classification association are different, so that:

- a user defined class can have information about it such as an identification, a description, the time and date at which the class was created, and an approval status; and
- a classification association can have information about it such as the date and time that the object was classified and an approval status.

The date and time of creation for a class precedes the date and time at which the class is used to classify something.

6 – A classification association can reference either a standard class defined within this part of ISO 10303 or a user defined class.

This part of ISO 10303 defines a libraries of standard classes that can be used to exchange or share information about the nature of an object without prior agreement between the parties to the exchange or sharing.

Each standard class within a library is an instance of an application object that is a class. The standard instances are defined in annex M, and held in tables. The standard instances are divided into tables according to discipline or use. These tables and the UoFs to which they belong are shown in table 1.

4.1.1 activity UoF

The activity UoF defines an activity and the things involved in an activity, which can be a process activity carried out by a process plant or a design activity carried out by a person or organization.

The things that play a role in an activity can be as follows:

- plant items (see 4.1.15);

Table 1 – Listing of standard instance tables

table of standard instances	UoF
Class_of_activity for design	activity
Class_of_activity for processes	activity
Class_of_annotation_element	schematic_presentation_and_-layout
Class_of_facility for Connector_of_facility	classification_of_plant_item
Class_of_facility for generic classification	classification_of_plant_item
Class_of_facility for heat transfer	classification_of_plant_item
Class_of_facility for instrumentation and control	classification_of_plant_item
Class_of_facility for piping and insulation	classification_of_plant_item
Class_of_facility for plants and systems	classification_of_plant_item
Class_of_facility for rotating and reciprocating equipment	classification_of_plant_item
Class_of_facility for valves	classification_of_plant_item
Class_of_facility for vessels	classification_of_plant_item
Class_of_facility for Logical_information_carrier	information_and_document
Class_of_information_content for identification	identification
Class_of_information_content for design documentation	information_and_document
Class_of_information_content for natural language	information_and_document
Class_of_involvement	activity
Class_of_material for generic classification	classification_of_plant_item
Class_of_material for heat transfer	classification_of_plant_item
Class_of_material for heat transfer equipment components	classification_of_plant_item
Class_of_material for instrumentation and control	classification_of_plant_item
Class_of_material for instrumentation and control components	classification_of_plant_item
Class_of_material for piping and insulation	classification_of_plant_item
Class_of_material for plants and systems	classification_of_plant_item
Class_of_material for rotating and reciprocating equipment	classification_of_plant_item
Class_of_material for valves	classification_of_plant_item
Class_of_material for valve components	classification_of_plant_item
Class_of_material for vessels	classification_of_plant_item
Class_of_material for vessel components	classification_of_plant_item

Table 1 – Listing of standard instance tables (concluded)

table of standard instances	UoF
Class_of_material for Physical_information_carrier	information_and_document
Class_of_property for composition	composition_and_connection_-of_plant_item
Class_of_property for Material and Activity	property
Class_of_property for Physical_information_carrier	information_and_document
Class_of_substance for Phase	process_material_and_substance
Class_of_substance for Process_material	process_material_and_substance
Classification_of_class_of_facility	library_of_classes
Classification_of_class_of_material	library_of_classes
Property enumerations for colour	schematic_appearance
Recognized_involvement_for_activity_according_to_class for design	involvement_constraint
Recognized_involvement_for_activity_according_to_class for processes	involvement_constraint

– people and organizations (see 4.1.2);

– anything that can be approved (see 4.1.3);

– information (see 4.1.11);

– process materials (see 4.1.17); and

– effects (see 4.1.8).

This UoF provides the ability to exchange or share:

– activities and their classes, and the composition and temporal sequence relationships between activities;

– the roles played by things in activities, and the nature of these roles.

This UoF defines a standard set of classes of activity. Additional classes may be defined by the user.

This UoF defines a standard set of classes of involvement that indicate the nature of a role played in an activity. Additional classes may be defined by the user.

NOTE 1 – This UoF can be used in conjunction with the plant_item (see 4.1.15), process_material (see 4.1.17), administration (see 4.1.2), approval (see 4.1.3), information_and_document (see 4.1.11), and effect (see 4.1.8) UoFs containing things involved in an activity.

The following application objects are used by the activity UoF:

- Activity;
- Class_of_activity;
- Class_of_involvement;
- Classification_of_activity;
- Classification_of_involvement;
- Composition_of_activity;
- Involvement_of_object_in_activity;
- Temporal_sequence_of_activity.

4.1.2 administration UoF

The administration UoF defines people and organizations that can be involved in activities, and the ownership and control over plant items exercised by organizations.

This UoF provides the ability to exchange or share:

- information about the ownership and control of organizations over plant items and intellectual property;
- information about the holding of a position within an organization by a person;
- organizational structure.

NOTE 1 – This UoF can be used in conjunction with:

- the plant_item UoF (see 4.1.15) containing a plant item that is owned or operated;
- the information_and_document UoF (see 4.1.11) containing intellectual property that is owned;
- the activity UoF (see 4.1.1) containing an activity in which a person or organization is involved.

The following application objects are used by the administration UoF:

- Composition_of_organization;
- Control_of_information_content_by_organization;
- Custody_of_material_by_organization;
- Holding_of_organizational_position_by_person;
- Operation_of_facility_by_organization;

- Organization;
- Ownership_of_intellectual_property_by_organization;
- Ownership_of_material_by_organization;
- Person.

4.1.3 approval UoF

The approval UoF associates anything within the scope of this part of ISO 10303 with an approval status with respect to a purpose. A purpose may be a specified activity, or any activity that is a member of a specified class.

This UoF provides the ability to exchange or share information about approval status of either a thing or of a data record for a thing.

NOTE 1 – This UoF is used in conjunction with the UoF that contains an assessed object.

This UoF is used in conjunction with the activity UoF (see 4.1.1) containing an activity or class of activity that is the purpose of the approval. The activity UoF can also contain an assess activity that creates an approval.

This UoF can be used in conjunction with the effect UoF (see 4.1.8) that contains the beginning or end of an approval assignment.

An object in the real world can be approved. This object in the real world can be something that actually exists or an intention for something that can exist. A data record in a computer system that records the existence of the object in the real world can also be approved.

NOTE 2 – Approval can be assigned to:

a) an object, such as an intended heat exchanger; or

b) a set of data records about the object.

In case a the approval is of the intent and the information involved in the approval must be deduced from the purpose of the approval.

In case b the approval is of the set of data records, and not necessarily of the objects that are recorded by them. A data record in the set containing information about the heat exchanger can record a pipe segment connected to the heat exchange. The approval of the set of data records for a purpose connected with the heat exchanger does not imply approval of the pipe segment.

The following application objects are used by the approval UoF:

- Approval_of_object;
- Composition_of_data_record.

4.1.4 catalogue_of_standard_items UoF

The catalogue_of_standard_items UoF contains reference plant items and symbols. A specific plant item within an actual or intended process plant can be derived from a reference (or typical) plant item. A symbol in a schematic presentation of information can be derived from a reference symbol.

Reference plant items or reference symbols can be collected together into catalogues.

This UoF provides the ability to exchange or share reference plant items and symbols and catalogues of them.

NOTES

1 – This UoF is used in conjunction with the plant_item UoF (see 4.1.15) containing a plant item that is either specific and in an intended or actual process plant, or a reference concept in a catalogue.

This UoF is used in conjunction with the schematic_presentation_and_layout UoF containing a symbol that is either in a specific presentation of information, or a reference concept in a catalogue.

2 – This UoF can be used in conjunction with the variance_and_derivation UoF (see 4.1.22) containing a derivation association that associates a reference plant item or symbol with its specific usage.

3 – This UoF can be used in conjunction with the composition_and_connection_of_plant_item UoF (see 4.1.6) containing an association that collects plant items. A collection of typical plant items is a catalogue.

4 – This UoF can exchange or share information about catalogues of typical plant items, separate from any specific plant items in an actual or intended process plant.

A plant item is either:

typical: a reference item that is the common aspect of a family of items; or

specific: an item that has a unique existence or is intended to have a unique existence within a process plant.

NOTES

5 – The term ‘typical’ is defined in 3.5.31. The term ‘specific’ is defined in 3.5.30.

6 – A collection of typical plant items is contained within a catalogue issued by a parts supplier.

A collection of specific plant items is contained within a bill of materials.

The following application objects are used by the catalogue_of_standard_items UoF:

- Specific_object;
- Typical_object.
- Typical_or_specific_object.

4.1.5 classification_of_plant_item UoF

The classification_of_plant_item UoF classifies a plant item within a process plant or a complete process plant. This UoF provides both a functional and a physical classification.

This UoF provides the ability to exchange or share multiple classifications of a single plant item.

This UoF defines a standard set of functional and physical classes of plant item. Additional classes may be defined by the user.

NOTE 1 – This UoF can be used in conjunction with the plant_item UoF (see 4.1.15) containing a classified plant item.

A functional plant item may have one or more functional classifications. A functional plant item may also be associated with one or more physical classifications. These indicate the classes of physical plant item that are recognized to be appropriate as a resource to provide the service.

A physical plant item may have one or more physical classifications. A physical plant item object may also be associated with one or more functional classifications. These indicate the classes of functional plant item that are recognized to be appropriate as a service provided by the resource.

This leads to associations between functional and physical plant items and functional and physical classes, as follows:

functional classification of a functional item: a classification of a functional plant item by its nature.

EXAMPLE 13 – The heat exchanger E-4507 in annex L is classified by its nature as a heat_exchange.

recognized physical class for a functional item: an association between a functional plant item and a physical class recognized as appropriate for its resource.

EXAMPLE 14 – The heat exchange E-4507 in annex L has a physical class shell_and_tube_heat_exchanger recognized as appropriate for its resource.

physical classification of a physical item: a classification of a physical plant item by its nature.

EXAMPLE 15 – The physical item that provides the service E-4507 in the example in annex L is classified by its nature as a shell_and_tube_heat_exchanger.

recognized functional class for a physical item: an association between a physical plant item and a functional class recognized as appropriate for its service.

EXAMPLE 16 – The physical item that is the centrifugal pump providing the service P-4506-A in annex L has a functional class pump recognized as appropriate for its service.

NOTE 2 – If a physical plant item is associated with a physical plant item for which it provides the service, then a recognized functional class for the physical plant item is superfluous information.

However a physical pump (say) that actually exists in the stores, or a standard pump in a catalogue, is not associated with a functional plant item. In this case the association between the physical plant item, whether actually existing in the stores or in the catalogue, and the class of its potential service is important information.

The following application objects are used by the classification_of_plant_item UoF:

- Class_of_facility;
- Class_of_material;
- Classification_of_facility;
- Classification_of_material;
- Recognized_class_of_resource_for_facility;
- Recognized_class_of_service_for_material.

4.1.6 composition_and_connection_of_plant_item UoF

The composition_and_connection_of_plant_item UoF defines both the functional and the physical composition and connectivity of plant items.

This UoF provides the ability to exchange and share:

- the functional composition and connectivity of functional plant items, and the physical composition and connectivity of physical plant items;
- the topological sequence information of functional plant items, without explicit connection information; and
- information about the functional plant items used in a functional connection;
- information about the physical plant items and features used in a physical connection.

NOTE 1 – This UoF is always used in conjunction with the plant_item UoF (see 4.1.15) containing plant items for which composition and connections are specified.

The functional composition of functional plant items and the physical composition of the physical plant items that provide the resource are independent and need not correspond directly.

NOTE 2 – This part of ISO 10303 can record either the functional composition of functional plant items, or the physical composition of physical plant items, or both.

EXAMPLE 17 – The functional plant items 45-FIC-501 and 450-FIC-502 are two controller within different loops.

For each functional plant item there is a circuit board - a physical plant item. The two circuit boards are physically both within the same cabinet.

The two controllers can be, but need not be, functionally both within the same control system.

The functional connections of functional plant items and the physical connections of the physical plant items that provide the resource are independent and need not correspond directly.

NOTE 3 – This part of ISO 10303 can record either the functional connections of functional plant items, or the physical connections of physical plant items, or both.

EXAMPLE 18 – Pipe segment SD-310 discharges into the settlement tank VS-310. There is a functional connection between these functional plant items.

The pipe that is the resource for SD-310 and the open reinforced concrete tank that is the resource for VS-310 are physical plant items. They can be, but need not be, physically connected.

The following application objects are used by the composition_and_connection_of_plant_item UoF:

- Assembly_of_facility;
- Assembly_of_material;
- Collection_of_facility;
- Collection_of_material;
- Composition_of_facility;
- Composition_of_material;
- Connection_of_facility;
- Connection_of_material;
- Connector_of_facility;
- Feature;
- Possession_of_connector_by_facility;
- Possession_of_feature_by_material;
- Topologic_sequence_of_facility;
- Usage_of_facility_in_connection;
- Usage_of_feature_in_connection_of_material;
- Usage_of_material_in_connection.

4.1.7 data_inheritance UoF

The data_inheritance UoF provides a method for defining two similar sets of data relevant to two similar objects by specifying the difference between the sets of data.

NOTE 1 – Data inheritance can be used to specify a variant of an intended plant item.

This UoF provides the ability to exchange or share information about the data relevant to one object that is inherited by another similar object.

NOTE 2 – This UoF is used in conjunction with other UoFs containing objects for which data is relevant, and objects that are inherited.

The following application objects are used by the data_inheritance UoF:

– Exclusion_of_association_from_inheritance;

– Inclusion_of_association_as_valid_within_context;

– Inheritance_of_valid_associations.

4.1.8 effect UoF

The effect UoF associates anything within the scope of this part of ISO 10303 with the date, time, place and cause of its beginning or end.

This UoF provides the ability to exchange or share information about the beginning or end of either a thing or of a data record for a thing.

NOTE 1 – This UoF is used in conjunction with the UoF containing objects that begin or end.

This UoF can be used in conjunction with the activity UoF (see 4.1.1) containing an activity that is the cause of a beginning or end.

Any object, whether actual or an intention, in the real world has a beginning and ultimately an end. A data record in a computer system that records the existence of the object also has a beginning and an end.

NOTE 2 – The beginning or end of a data record do not necessarily happen at the same time at the beginning or end of the object that is recorded.

If a data record is created for something that already exists, then the beginning or the data record happens after the beginning of the object in the real world.

If a data record in an asset management system is created for a plant item that has not yet been delivered, then the beginning of the data record can happen before the beginning of the real world object.

A beginning or end may be assigned to an association.

NOTE 3 – This part of ISO 10303 records a relationship between application objects as another application object. This enables a change to a relationship between application objects to be recorded.

Consider an association between a intended plant item such as a vessel and a property such as an operating pressure. If the intended operating pressure is changed, then the association between the vessel and the old operating pressure is ended and an association between the vessel and a new operating pressure begins.

A history of changes is recorded by beginning and end information.

The following application objects are used by the effect UoF:

– Beginning_effect;

– Beginning_or_end_effect;

– Date_and_time;

- Description_of_point_in_time_by_date_and_time;
- End_effect;
- Point_in_time.

4.1.9 hierarchical_decomposition UoF

The hierarchical_decomposition UoF defines a hierarchical decomposition of both functional and physical plant items.

This UoF provides the ability to exchange and share:

- a functional decomposition hierarchy for functional plant items, and a physical decomposition hierarchy for physical plant items;
- information about the purpose of the hierarchy.

NOTES

1 – This UoF is always used in conjunction with the composition_and_connection_of_plant_item UoF (see 4.1.6) containing composition associations that are collected together to define the hierarchy.

2 – This UoF can be used in conjunction with the administration UoF (see 4.1.2) containing an organization that uses a hierarchy.

This UoF can be used in conjunction with the activity UoF (see 4.1.1) containing an activity or class of activity that uses a hierarchy.

The following application objects are used by the hierarchical_decomposition UoF:

- Collection_of_composition_of_facility_into_hierarchy;
- Collection_of_composition_of_material_into_hierarchy;
- Hierarchy_of_composition_of_facility;
- Hierarchy_of_composition_of_material;
- Valid_context_for_hierarchy_of_composition_of_facility;
- Valid_context_for_hierarchy_of_composition_of_material.

4.1.10 identification UoF

The identification UoF provides identification for:

- plant items and provision of service associations (see 4.1.15);
- connections between plant items and features of plant items (see 4.1.6);

– classes of plant item, property and information (see 4.1.5);

– activities (see 4.1.1);

– information and documents (see 4.1.11);

– organizations and people (see 4.1.2);

– positions and orientations (see 4.1.16);

– properties (see 4.1.18);

– beginning and end effects and times (see 4.1.8);

– approvals (see 4.1.3);

– hierarchical decomposition views (see 4.1.9);

– data records.

NOTE 1 – The list of application objects that can be identified is contained in Described_object (see 4.2.79.1).

This UoF provides the ability to exchange or share:

– many different identifications for the same object;

The identifications may be of different types, used for different purposes or used by different organizations.

– an identification of a data record as well as an identification of the object that a data record records;

NOTE 2 – Name and label are different types of identification, and a plant item can have one of each.

– information about the circumstances in which a particular identification is used;

– information about the identification scheme used to create an identification and about the maintainer of that identification scheme.

This UoF defines a standard set of classes for identifier. Additional classes may be defined by the user.

NOTES

3 – This UoF is always used in conjunction with another UoF containing an identified object.

4 – This UoF is always used in conjunction with the information_and_document UoF (see 4.1.11), containing identifier text and its classification (as a name or label say).

5 – This UoF can be used in conjunction with the administration UoF (see 4.1.2) containing an organization that maintains an identification scheme, or uses an identification.

This UoF can be used in conjunction with the activity UoF (see 4.1.1) containing an activity or class of activity that uses a hierarchy.

An object in the real world may be identified. The data record in a computer system that records the existence of the object in the real world may also be identified.

NOTE 6 – The identification of a data record is usually assigned by computer and is usually not intended to be used by people. However, this identification can be persistent, and can be used by several different computer systems.

This UoF provides the ability to exchange or share both types of identification.

The following application objects are used by the identification UoF:

- Data_record;
- Identification_of_object_by_information_content;
- Maintenance_of_identification_scheme;
- Valid_context_for_identification.

4.1.11 information_and_document UoF

The information_and_document UoF provides a description for:

- plant items and provision of service associations (see 4.1.15);
- connections between plant items and features of plant items (see 4.1.6);
- classes of plant item, property and information (see 4.1.5);
- activities (see 4.1.1);
- information and documents (see 4.1.11);
- organizations and people (see 4.1.2);
- positions and orientations (see 4.1.16);
- properties (see 4.1.18);
- beginning and end effects and times (see 4.1.8);
- approvals (see 4.1.3);
- hierarchical decomposition views (see 4.1.9).

NOTE 1 – The list of application objects that can be described is given in 4.2.79.1.

A description may be provided by information content (text, numeric or binary objects) or by a reference to information content held elsewhere. A description may be provided by an association with a holder of information content such as a document or computer file.

This UoF provides the ability to exchange or share:

- information content, and associations with described objects;
- references to information content and holders or information content, and associations with described objects;
- the classification of information content according to the meaning conveyed and according to the language or other formalism used;

  NOTE 2 – An information content can be classified as a process data sheet. It can also be classified as French, and as SGML.

- the classification of information content held by an information holder, and the classification of an information holder according to its nature;

  NOTES

  3 – A document can contain information content classed as a process data sheet, and French. A document can be classified as being formatted for A4 size paper.

  4 – The term 'information holder' is defined in 3.5.12.

- the association between an information holder and the information content that it contains;
- references between information holders.

This UoF defines a standard set of classes for information content. Additional classes may be defined by the user.

This UoF defines a standard set of classes for information holders. Additional classes may be defined by the user.

NOTES

5 – This UoF can be used in conjunction with another UoF containing a described object.

6 – This UoF can be used in conjunction with the plant_item UoF (see 4.1.15) containing a holder of information content.

A computer file that is held within a computer system is a logical plant item. A document that is ink on paper is a physical plant item.

This UoF supports two types of business practice:

document or file based: In this practice, information content is managed via the documents or computer files that hold the information content.

information based: In this practice, a text string or binary object is managed as an object, separate from any particular carrier.

NOTE 7 – An information based business practice requires the identification of information content, and the recording of version and approval information about information content. This information is within the identification UoF (see 4.1.10) and the approval UoF (see 4.1.3).

The following application objects are used by the information_and_document UoF:

- Binary_object;
- Class_of_information_content;
- Class_of_information_content_held_by_information_carrier;
- Classification_of_information_content;
- Definition_of_object_by_information_content;
- Definition_of_object_via_information_carrier;
- Description_of_object_by_information_content;
- Description_of_object_via_information_carrier;
- Holding_of_information_content_by_information_carrier;
- Information_content;
- Logical_information_carrier;
- Physical_information_carrier;
- Reference_between_information_carrier;
- Reference_to_object_by_information_content;
- Reference_to_object_via_information_carrier;
- Text.

4.1.12 involvement_constraint UoF

The involvement_constraint UoF provides a structure for defining the different ways in which a thing may play a role in an activity.

This UoF provides the ability to exchange or share:

- constraints that specify the classes of role played by a thing that are valid for a particular class of activity;

– constraints that specify the classes of thing that are valid for a particular class of role;

– constraints that specify the classes of thing that are valid for a particular combination of class of role and class of activity.

This UoF defines standard sets of constraints based upon standard classes of involvement and activity (see 4.1.1) and plant item (see 4.1.5). Further constraints on the standard classes, and constraints on user defined classes, may be defined by the user.

NOTES

1 – This UoF is used in conjunction with the activity UoF (see 4.1.1) containing classes of activity and involvement, and the classification_of_plant_item UoF containing classes of plant item.

2 – This UoF can exchange or share information about constraints upon classes, without any activities, involvements or plant items that are classified.

The following application objects are used by the involvement_constraint UoF:

– Involved_class_of_object;

– Recognized_involvement_for_activity_according_to_class;

– Recognized_involvement_in_activity_for_object_according_to_class;

– Recognized_object_for_role_according_to_class.

4.1.13 library_of_classes UoF

The library_of_classes UoF provides a library structure for classes of plant item, property, symbol and information content.

This UoF provides the ability to exchange or share:

– a class library for plant items and constraints on the valid assemblies, connections, provisions of service and descriptions of plant items according to class;

– a class library for properties and constraints upon the possession of properties by plant items according to class.

– a class library for symbols and constraints upon the valid use of symbols to stand for plant items according to class;

– a class library for information content and constraints upon the composition of information content and the use of information content to describe plant items according to class.

This UoF defines standard sets of constraints based upon the standard classes of plant item, property, and information content defined in the plant_item (see 4.1.15), property (see 4.1.18), information_and_document (see 4.1.11) and schematic_presentation_and_layout (see 4.1.21) UoFs. Further constraints on the standard classes, and constraints on user defined classes, may be defined by the user.

NOTES

1 – This UoF is used in conjunction with the plant_item (see 4.1.15), property (see 4.1.18), information_and_document (see 4.1.11) and schematic_presentation_and_layout (see 4.1.21) UoFs containing classes.

2 – This UoF can exchange or share information about libraries of classes, without any plant items that are classified. In this case, this UoF is not used in conjunction with the plant_item UoF (see 4.1.15).

The following application objects are used by the library_of_classes UoF:

- Classification_of_class_of_annotation_element;
- Classification_of_class_of_facility;
- Classification_of_class_of_material;
- Collection_of_class_of_annotation_element;
- Collection_of_class_of_facility;
- Collection_of_class_of_information_content;
- Collection_of_class_of_material;
- Collection_of_class_of_property;
- Recognized_assembly_of_annotation_element_according_to_class;
- Recognized_assembly_of_facility_according_to_class;
- Recognized_assembly_of_material_according_to_class;
- Recognized_composition_of_information_content_according_to_class;
- Recognized_connection_of_annotation_element_according_to_class;
- Recognized_connection_of_facility_according_to_class;
- Recognized_connection_of_material_according_to_class;
- Recognized_description_of_object_according_to_class;
- Recognized_possession_of_property_according_to_class;
- Recognized_presentation_of_facility_by_annotation_element_according_to_class;
- Recognized_presentation_of_material_by_annotation_element_according_to_class;
- Recognized_provision_of_service_according_to_class.

4.1.14 life_cycle UoF

The life_cycle UoF indicates whether something actually exists or is an intention. Something that exists may be associated with the intention that preceded it.

NOTES

1 – The term 'actual' is defined in 3.5.1. The term intended is defined in 3.5.15.

2 – An intended plant item and an actual plant item are separate objects. Information about the intended plant item is information about the intention. Information about the actual plant item is information known about what actually exists, i.e. information that has been obtained by observation or measurement.

3 – Any application object can be actual. The list of application objects that can be intended is contained in Life_cycle_object (see 4.2.105).

This UoF provides the ability to exchange or share:

- an indication of whether an object actually exists or is an intention;
- an association between an actual object and a corresponding intention that preceded it.

NOTE 4 – This UoF is used in conjunction with other UoFs containing objects that are actual or intended.

The following application objects are used by the life_cycle UoF:

- Actual_object;
- Intended_object;
- Life_cycle_object;
- Realization_of_intended_object_by_actual.

4.1.15 plant_item UoF

The plant_item UoF contains a record of the items within a process plant that play a role in the operation of the plant. An item may be a complete plant or any sub-division of a plant down to a single component.

An item may be a functional item (Facility), or a physical item (Material). A provision of service association relates a functional item to a physical item that provides the service.

This UoF provides the ability to exchange or share records of functional and physical items, and provision of service associations between them.

NOTE 1 – This UoF does not provide any information about a functional or a physical item other than its existence, and optionally its involvement in a provision of service association.

This UoF is always used in conjunction with another UoF, such as the identification UoF, providing further information about plant items.

This part of ISO 10303 provides two views of a process plant, as follows:

functional view: a view in which the plant is divided into items on the basis of the service that the items provide.

The items within a functional view are Facilities. Information about the service provided is associated with a Facility.

NOTE 2 – The identification of a Facility is usually called a 'tag'.

physical view: a view in which the plant is divided into items on the basis of their physical nature.

The items within a physical view are Material objects. Information about the physical nature is associated with a Material object.

NOTE 3 – The identification of a Material object can be a serial number assigned by its manufacturer or an asset number assigned by its operator.

NOTE 4 – Most Activities supported by this part of ISO 10303 require both views. However Activities classed as process design, commissioning, operation and decommissioning are principally concerned with Facilities, and Activities classed as engineering design, construction, maintenance and demolition are principally concerned with Material objects.

EXAMPLE 19 – The P&ID in annex L, identifies the Facilities in the distillate transfer system and shows their connections, but also provides information about the Material objects.

In particular the reducers are shown event though they are Material objects and not Facilities. Also V4 is presented by a globe valve symbol which indicates the nature of the Material that provides the service.

The following application objects are used by the plant_item UoF:

- Facility;
- Material;
- Provision_of_service_by_material.

4.1.16 position_and_orientation UoF

The position_and_orientation UoF describes the position and orientation of a plant item.

This UoF provides the ability to exchange or share the identification and description of a position of a plant item and an orientation of a plant item.

NOTES

1 – This UoF is always used in conjunction with the plant_item UoF (see 4.1.15 containing a plant item that has a position or orientation.

2 – A position and orientation can be something vague, such as a room or part of a site or something precise, such a particular point. The description of a position and orientation is within the scope of this part of ISO 10303.

The precise co-ordinates of a position and orientation with respect to a frame of reference are within the scope of ISO 10303 part 227.

The following application objects are used by the position_and_orientation UoF:

- Orientation;
- Orientation_of_material;
- Orientation_of_resource_for_facility;
- Point_in_space;
- Point_in_space_of_material;
- Point_in_space_of_resource_for_facility.

4.1.17 process_material_and_substance UoF

The process_material_and_substance UoF defines the process materials that are subject to transfer and transformation by a process plant, and classifies process material by phase and by substance.

EXAMPLE 20 – Sea water, crude oil and carbon dioxide are classes of substance.

This UoF classifies plant items that provide services within a process plant, such as equipment items, on the basis of the chemical composition and physical state of the substance that forms the plant item.

EXAMPLE 21 – Cast iron, carbon steel and titanium are classes of substance.

This UoF provides the ability to exchange or share:

- information about the class of a component or equipment item determined by its fabrication history that is relevant to a materials engineer;
- information about the chemical composition and state of a process fluid that is relevant to a chemical engineer.

NOTE 1 – This UoF can be used in conjunction with the activity UoF (see 4.1.1) containing a transfer or transform activity carried out upon process material.

The following application objects are used by the process_material_and_substance UoF:

- Class_of_substance;
- Classification_of_material_by_class_of_substance;
- Classification_of_process_material_by_phase;
- Phase;
- Process_material.

4.1.18 property UoF

The property UoF provides the capability of defining the properties and their numeric values for the following:

- plant items (see 4.1.15);
- classes of plant item (see 4.1.5);
- features of plant items (see 4.1.6);
- activities and classes of activity (see 4.1.1);
- documents and other information carriers (see 4.1.11).

This UoF provides the ability to exchange or share:

- single numeric values or ranges of values for properties of plant items, classes of plant item, activities and classes of activity;

  NOTE 1 – A property of a class is a basis for membership of the class, such that it is necessary for an object to have the property in order to be a member of the class.

- the different values for the same property that result from changes to the design of a process plant, or from changes to an actual process plant during its life;
- the identification and description of properties by text as well as their numeric values;
- property information about that applies either to collections of plant items as a whole or to each member of the collection;

This UoF defines a standard set of property classes. Additional classes may be defined by the user.

NOTES

2 – This UoF can be used in conjunction with the plant_item UoF (see 4.1.15), the classification_of_plant_item UoF (see 4.1.5) or the activity UoF (see 4.1.1) containing an object that possesses a property.

3 – The dependence of one property upon another, such as viscosity upon temperature, is not within the scope of this part of ISO 10303.

This part of ISO 10303 distinguishes between:

property: an aspect of a thing that can be observed or measured; and

value: a number with or without a unit or measure, or a text string, that describes a property.

NOTE 4 – A value of a property can be measured for a thing that actually exists or can be deemed as part of the design process for a thing that is intended to exist.

This UoF provides the ability to exchange or share:

– the information that two plant items have the same property, when no value for that property has been measured or deemed;

– a textual description of a property as well as, or instead of, its value.

The following application objects are used by the property UoF:

– Class_of_property;

– Classification_of_property;

– Composition_of_information_content;

– Enumerated_property_in_class_of_property;

– Numeric_operator;

– Numeric_value;

– Possession_of_property_by_each_member_of_collection;

– Possession_of_property_by_object;

– Property;

– Property_basis_for_class_membership;

– Unit_of_measure.

4.1.19 required_information UoF

The required_information UoF specifies the information that is required as input to, or output from, either a specific activity or any activity of a class.

This UoF provides the ability to exchange or share:

– a specification of those properties possessed by a plant items for which a value is required on input, to or output from, an activity;

– a specification of the documentation for a plant item that is required on input to or output from an activity.

The requirements are expressed in terms of the class of plant item and a specific activity or a class of activity.

NOTES

1 – This UoF is used in conjunction with the plant_item (see 4.1.15), property (see 4.1.18), information_and_document (see 4.1.11) UoFs containing classes.

This UoF is used in conjunction with the activity UoF (see 4.1.1) containing a specific activity or class of activity for which information is required.

2 – This UoF can exchange or share information about requirements for information without any plant items that have the information. In this case, this UoF is not used in conjunction with the plant_item UoF (see 4.1.15).

The following application objects are used by the required_information UoF:

- Required_input_description_according_to_class;
- Required_input_of_property_value_according_to_class;
- Required_output_description_according_to_class;
- Required_output_of_property_value_according_to_class.

4.1.20 schematic_appearance UoF

The schematic_appearance UoF contains the appearance of elements of a schematic presentation.

This UoF provides the ability to exchange or share:

- a colour, point symbol, line fount, text fount, hatching pattern or tiling for an element of a schematic presentation;
- a view definition in which the schematic is clipped geometrically and in which some elements are not visible.

NOTE 1 – This UoF is used in conjunction with the schematic_presentation_and_layout UoF (see 4.1.21) containing elements of a schematic presentation that have appearance.

The following application objects are used by the schematic_appearance UoF:

- 2d_box_dimensions;
- 2d_scale;
- 2d_vector;
- Appearance_for_annotation_text;
- Clipping_box_for_derivation;
- Colour_rgb;
- Description_of_hatching_by_pitch;
- Description_of_tiling_by_pattern;
- Hatching_derivation_for_annotation_element;

- Invisible_annotation_element_in_view;
- Leader_terminator_for_annotation_curve;
- Line_pattern;
- Line_pattern_for_annotation_curve;
- Point_marker_symbol;
- Scaling_for_derivation;
- Terminator_symbol;
- Text_appearance;
- Text_box_for_annotation_text;
- Tiling_derivation_for_annotation_element;
- Tiling_pattern;
- View_derivation_for_annotation_element;
- Width_for_annotation_curve.

4.1.21 schematic_presentation_and_layout UoF

The schematic_presentation_and_layout UoF contains the layout of a schematic presentation and the association between the elements of the schematic presentation and the things that are presented:

- plant items (see 4.1.15);
- identifications of plant items (see 4.1.10);
- classifications of plant items (see 4.1.5);
- composition and connection of plant items (see 4.1.6);
- properties of plant items (see 4.1.18);
- activities (see 4.1.1); and
- effects (see 4.1.8).

This UoF provides the ability to exchange or share:

- a schematic presentation of information about a process plant;

NOTE 1 – This UoF can be used to share or exchange a P&ID of PFD.

– connectivity information about the annotation objects within a schematic presentation;

NOTE 2 – This information is not the same at the connectivity of the plant items. In practice the schematic connectivity should be equivalent to the connectivity of the plant items, but the imposition of equivalence is not within the scope of this part of ISO 10303.

– information about the drawing or drawing sheet that contains the schematic presentation.

NOTES

3 – This UoF is used in conjunction with the schematic_appearance UoF (see 4.1.20) containing an appearance of elements within a schematic presentation.

4 – This UoF can be used in conjunction with the plant_item (see 4.1.15), identification (see 4.1.10), classification_of_plant_item (see 4.1.5), composition_and_connection_of_plant_item (see 4.1.6), property (see 4.1.18), activity (see 4.1.1), and effect (see 4.1.8) UoFs that contain things that are presented.

The UoF is not used in conjunction with these UoFs if the schematic presentation is not associated with the things that are presented. Such a presentation is termed 'dumb'.

5 – The list of objects that can be presented is given in 4.2.135.1.

6 – This UoF can be used in conjunction with the information_and_document UoF (see 4.1.11), containing a drawing or drawing sheet to contain a schematic presentation, and text strings that are presented.

The following application objects are used by the schematic_presentation_and_layout UoF:

– 2d_curve;

– 2d_direction_range;

– 2d_placement;

– Annotation_area;

– Annotation_curve;

– Annotation_element;

– Annotation_point;

– Annotation_text;

– Assembly_of_annotation_element;

– Centre_line_for_annotation_curve;

- Class_of_annotation_element;
- Classification_of_annotation_element;
- Collection_of_annotation_element;
- Composition_of_annotation_element;
- Connection_of_annotation_element;
- Connector_feature_of_annotation_element;
- Derivation_of_annotation_element;
- Description_of_display_by_placement;
- Description_of_relative_placement;
- Direction_range_for_connector_feature;
- Display_of_annotation_element_on_physical_information_carrier;
- Inner_boundary_for_annotation_area;
- Outer_boundary_for_annotation_area;
- Page_connector;
- Possession_of_connector_feature_by_annotation_element;
- Presentation_of_object_by_annotation_element;
- Reference_between_page_connector;
- Relative_placement_of_annotation_element.

4.1.22 variance_and_derivation UoF

The variance_and_derivation UoF contains the relationships between objects that record a sequence of design activities. This UoF also contains the relationship between a specific plant item in an intended or actual process plant, and a reference or catalogue item from which it is derived.

NOTE 1 – The list of objects that can have variants, derivatives or alternatives is given in 4.2.76.1.

This UoF provides the ability to exchange or share:

- the derivation of a plant item from a reference or catalogue item;